DATAMATION

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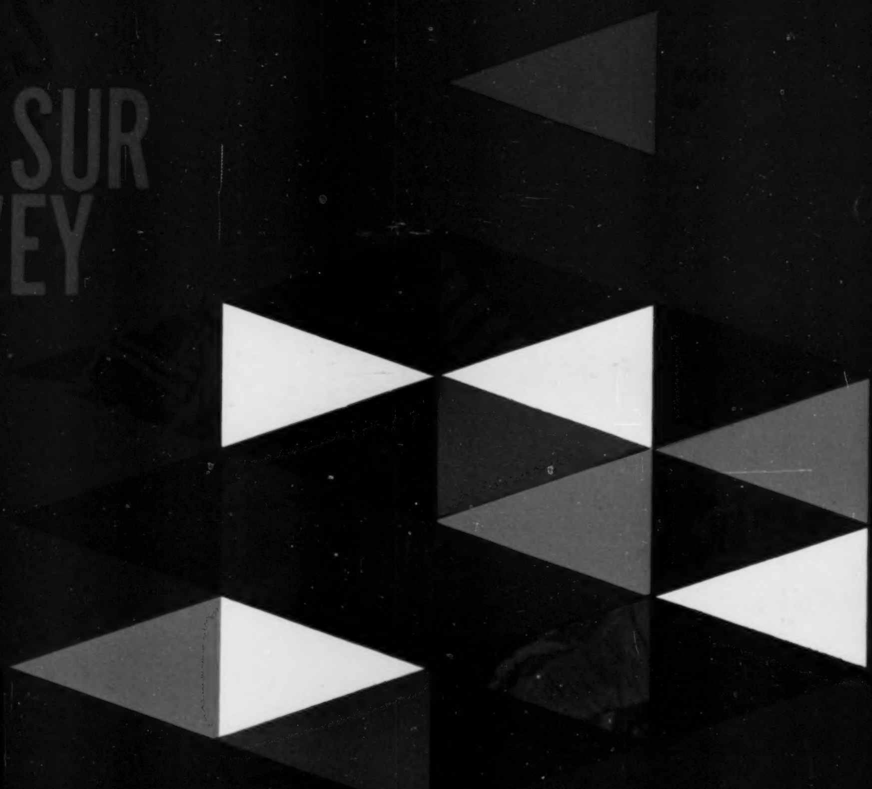
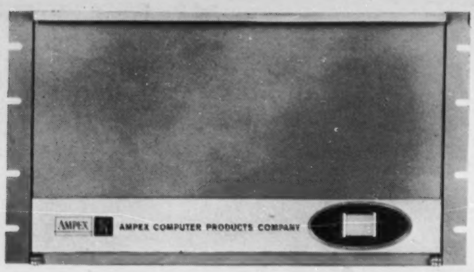
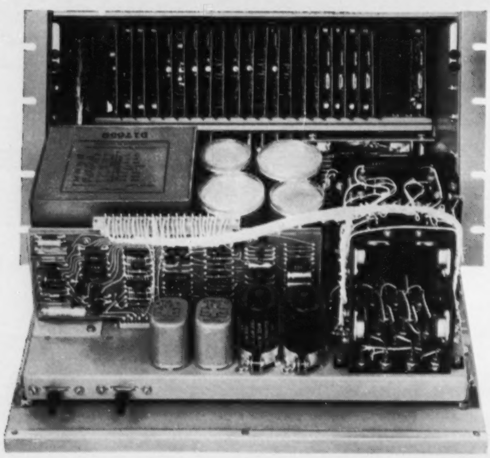




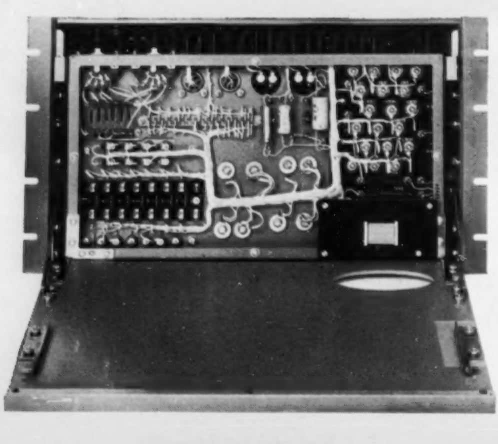
REMEMBER WHEN CORE MEMORIES LOOKED LIKE WAR SURPLUS?

MOST OF THEM STILL DO—BUT NOT THE AMPEX RB. IT'S SMALL . . . FITS NEATLY IN 10½" OF RACK SPACE. IT'S FAST . . . LOAD OR UNLOAD IN 5 MICROSECONDS, COMPLETE MEMORY CYCLE IN 8 MICROSECONDS. IT REMEMBERS . . . UP TO 1024 WORDS, 4 TO 24 BITS PER WORD. AND TOO, THE NEW AMPEX RB LOOKS LIKE WHAT IT IS: A PRODUCT OF THE COMPANY THAT PIONEERED CORE MEMORIES (FORMERLY TELEMETER MAGNETICS INC.).



BUT THERE'S MORE THAN BEAUTY BEHIND THE MODERN, SWING-DOWN FRONT PANEL . . . INSPECTION, MAINTENANCE, AND REPLACEMENT IS ACCOMPLISHED FROM THE FRONT . . . EVERY COMPONENT, EACH CIRCUIT, IS LITERALLY AT YOUR FINGERTIPS ALMOST INSTANTLY. WANT MORE INFORMATION ABOUT THE NEW LOOK IN CORE MEMORIES? WRITE: CORE MEMORY DIVISION, AMPEX COMPUTER PRODUCTS CO., P.O. BOX 329, CULVER CITY, CALIF.

AMPEX 0/1 T.M.
AMPEX COMPUTER PRODUCTS COMPANY



CIRCLE 1 ON READER CARD

DATAMATION 61

the automatic handling of information

volume 7, number **8**

Computer Components Survey

Articles

Departments

THIS ISSUE — 36,300 COPIES

Cover

Focusing on the broad spectrum of color, size and function in computer componentry, this month's cover design by Art Director Cleve Boutell, attractively symbolizes a special editorial treatment on this subject beginning on page 36.

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to the editor . . .

a grosch reply

Dear Sir:
May I have a little space to answer my June fan mail? First, Bob Angus should recognize the difference between an informative story, for laymen, in LIFE, and my designedly inflammatory column of personal opinion in an insiders' magazine. I hope not to be so cavalier as to regard black as one of the darker shades of white, and white as a somewhat grayed black; I'm not writing press releases! But I'm not aiming for eight-place accuracy either.

Having made that disclaimer, however, I don't see what Angus is kicking about. I'm grateful that an important part of BMEWS was allowed to be general-purpose; the fact that much of the system is, and perhaps had to be, special-purpose is beside the point. On the 7090 part, the taxpayers made out for once; and the profession did not have to condone with its customary silence, the wasting of scarce logical design and engineering talent.

Paul Brock, on the other hand, has caught me in a silly blunder. The GE computer in ERMA is a genuinely general-purpose machine; I must have been woolgathering about the 1955-56 SRI prototype. I was therefore really complaining about the purposelessness of another general-purpose computer, not about the special-purposeness of one that could have been general, and this was clearly out of context. Touche, Paul!

HERB GROSCH
New York City

computers and thinking

Dear Sir:
One hundred years ago man was looked upon as a machine; we are now returning the favor, and endowing machines with the attributes of man. For example, Berkeley actually believes a traffic light is an intelligent machine; Simon and Newell seriously hold (Datamation, June, 1961) that machines "play chess and checkers, find proofs for theorems in geometry and logic, compose music, balance assembly lines, design electric motors and generators, memorize nonsense syllables, form concepts and learn to read." The analogy to the unsophisticated biologist is striking: he might say "of course machines do these

things: our word for this class of machines is 'man'."

From a psychological perspective, whether you reduce man to machine or expand machine to man, a fundamental abdication is of course taking place. When Berkeley says the traffic light is intelligent he's really telling us how bright he is to discover this fact; he's bragging by implication that his recognition of intelligence implies some. Simon and Newell similarly. The truth of the matter is that computers do *not* think, play games, find proofs, compose music, design anything, have memories, form concepts or read. They don't even add. To take seriously the whole gamut of anthropomorphisms with which we've honored our own recent creations is nothing more than a disgraceful and crude narcissism.

Take the words "count" and "search" for instance. A child pushes a ball down a flight of stairs. Is the ball counting the steps as it bounces on each one? No. The concept "count" is a strictly human interpretation of a physical process. Suppose again a spot of fresh paint exists on the sixth step—can the ball be said to "search" for this spot? Again, "search" is something people do. The ball merely bounces. There are no alternatives. Finally, our computers only work properly *because* there are no alternatives. If both inputs to an and-gate go up the output goes up. No one would design or sell a piece of EDP equipment which actually makes a choice—we use people for that, and we always will.

P. B. WRIGHT
Ampex Computer Products Co.
Culver City, Calif.

on line processing

Dear Sir:

"... the nail on the head," that's what Mr. Blumenthal hit with his article in the June issue of Datamation. His description of such a system has been in use some time now since its inception at MIT's Lincoln Labs. This type of system is the basis of the SAGE, BMEWS, SACCS, etc. master programs. Was it by originality or previous knowledge of such a system that he arrived at his hypothesis? If it was by originality, may I congratulate him.

G. C. BECERRA
System Development Corporation
Santa Monica, Calif.

oops!

An error in the schedule for development of COBOL compilers (p. 41, July DATAMATION) incorrectly indicates a joint implementation effort with NCR and GE for the 315. Joint implementation is for the 304A and 304B only.

1961 IMPORTANT DATES

• WESCON is scheduled for the Cow Palace in San Francisco, Calif., August 22-25.

• SHARE VII meeting will be held from Aug. 23-25 at the Statler Hilton Hotel, Washington, D.C. For information, contact Dr. Aaron Finerman, Computing and Data Processing Div., Republic Aviation, Farmingdale, Long Island, N.Y.

• The National Symposium on Space Electronics and Telemetry will be held in Albuquerque, N.M., September 6-8. For information contact Dr. B. L. Basore, 2405 Parsifal, N. E., Albuquerque, N.M.

• International Symposium on the Transmission and Processing of Information will be held at the Mass. Institute of Technology, Cambridge, Mass. September 6-8. For information contact Peter Elias, RLE, MIT, Cambridge 39, Mass.

• The 1961 Annual Meeting of the Association for Computing Machinery will be held at the Statler Hilton, Los Angeles, on September 5-8. For information contact Benjamin Handy, Chairman Local Arrangements Committee, Litton Industries, Inc., 11728 W. Olympic Blvd., Los Angeles, Calif.

• The Third International Congress on Cybernetics is scheduled for Namur, Belgium, September 11-15. For information contact Secretariat of The International Association for Cybernetics, 13 rue Basse Marcelle, Namur, Belgium.

• The 12th National Conference on Standards is scheduled for October 10-12 in Houston, Texas. For information write to American Standards Assoc., 10 E. 40th St., N.Y. 16, N.Y.

• Univac Users Assoc. Fall Conference and USE meeting will be held Oct. 12-13 at the Warwick Hotel, Phila. For information contact Walter Edmiston, Phila. Naval Shipyard, Phila. 12, Penn.

• The 1961 Computer Applications Symposium, sponsored by Armour Research Foundation will be held Oct. 25-26, Morrison Hotel, Chicago. For information write to Benjamin Mittman, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

OLD GLOBE THEATRE
Shakespearean theatre is produced each summer in this reproduction of the 16th Century Globe Theatre. Modern plays are presented during the winter season.

SWIMMING . . . BOATING
Miles and miles of ocean and bay shores plus ideal year around weather make water sports a favorite pastime of many San Diegans.

CHILDREN'S ZOO
This section of the world-famous San Diego Zoo in 1400-acre Balboa Park affords hours of fun for the kids . . . riding the giant turtles, petting and holding baby animals.

UNIVERSITY OF SAN DIEGO
One of the outstanding Universities of higher l ing in San Diego. Others are University of fornia at San Diego, California Western Unive and San Diego State College.

PALOMAR OBSERVATORY
The largest telescope (200-inch) in the worl On display at Mt. Palomar are star photos a models of the universe.

RELAXATION
Here couples socialize in the shade of a palm overlooking the exciting San Diego Bay. Within full view of many restaurants and clubs is the activity of Navy ships, ocean liners, fishing boats and yachts.

ENGINEERING AND SCIENTIFIC PROGRAMMERS

Positions are for senior programmers with extensive experience on 7090 and 650 computers. An engineering background is most desirable, however, physics and mathematics majors with a demonstrated interest in programming are also acceptable.

The Engineering and Scientific Computer Laboratories are currently concerned with problems which include the following:

Dynamics; Thermodynamics; Aerodynamics; Simulation of Guidance Systems and Computers; Computer-Generated Displays; Development of Problem-Oriented Languages; Executive Programs and Monitors; Satellite and Trajectory Studies; Numerical Analysis; Logical Design; Statistical Analysis; Operations Analysis; Physics Research; Multi-Programming of the 7090 Computer for Real Time Applications.

Because of the advanced nature of work in progress, a degree is essential, preferably in engineering, applied mathematics, or physics.

BUSINESS DATA PROGRAMMERS

The Business Data Processing Laboratories have just been established at General Dynamics | Astronautics, providing what are truly "ground floor" opportunities with rapid advancement potential. This rapidly expanding capability has created many openings in business application and programming of digital data processing equipment related to production control, financial control, maintenance and management reports. Present equipment includes IBM 7070, 7090 and 1401 computers, and these positions require at least one year of experience with one or more of these machines. A systems background and college degree are highly desirable, but not essential if experience has demonstrated a high level of ability and interest in this field.

ALL QUALIFIED APPLICANTS WILL RECEIVE CONSIDERATION FOR EMPLOYMENT WITHOUT REGARD TO RACE, CREED, COLOR OR NATIONAL ORIGIN.

GENERAL DYNAMICS

ASTRONAUTICS

FORMERLY CONVAIR | ASTRONAUTICS

DATAMATION *in business and science*

FACT READY FOR AUGUST DELIVERY

The FACT compiler for the 800 is scheduled for delivery by the 3rd week in August, DATAMATION has learned from J.J. Franks, manager of dp for ConEdison in Southern California, and one of 10, 800 users. Almost a year late, six phases of the eight phase package have been completed since early March, and while the two remaining, comparatively non-critical phases have been checked out independently, bridging problems and housecleaning were the major chores for Computer Science Corp. during the past few months.

Despite its forthcoming availability, many 800 users have been running programs with the ARGUS assembler and will have to convert to FACT. For ConEdison, Franks feels the conversion process will require about six months.

RCA & BULL SIGN MARKETING AGREEMENT

RCA's EDP division and BULL, Europe's largest computer manufacturer, have signed a marketing agreement for "the sharing of patents,copyrights and technical assistance." An immediate result of this agreement will be the marketing of RCA equipment in Europe. Initially, about 95, 301s have been allocated for this purpose. At present, there are no plans for RCA to sell the BULL line such as Gamma 60 in this country, which might prove an interesting alternative to the 601.

ALWAC CONFIRMS ITS STAYING POWER

Long considered a prime prospect for "the weed out" (see page 17), Dr. Slaverson, president of ALWAC Computer Division of El-tronics, reports the sale of three, ALWAC IIIE computers and has confirmed his company's plans for ALWAC IV, the solid state version of the III, to be announced next year. Design studies on the IV are about to be frozen and include an updated tape transport, advanced drum work and transistorized relays. Letters of intent but no orders, are being accepted.

90 SUCCESSOR PERPLEXES IBMers

The customary Fall announcement of major hardware development from IBM may be postponed until January, as White Plains management has not as yet determined its large scale marketing plans for next year. Three alternatives seem likley: 1) souping up the 90's with a one microsecond core memory or better, and the introduction of faster tapes; 2) watering down STRETCH with perhaps not as complicated a look ahead feature and including some of the 7030's logical design, and 3) the introduction of an entirely new, asynchronous machine with Polish Notation, 72 bit word length, and half word logic for the transition from six to eight bit character tapes.

It is likely that a successor to the 90 will be improved in speed by a factor of 3 or 4 and feature some of the polymorphic concepts of the RW 400. Disc file storage will be part of the package in a

hook-up with the 1401.

Lack of decision by IBM is attributed to the need for compatibility of new equipment with the more than 100, 90 installations already announced and more to come. This fact would indicate that the first of the three choices (souping up the 90) would seem to be the most probable. Unless compatibility is assured, outdating the 90s by a major announcement would produce a flurry of shifting orders, and considerable disgruntlement from 90 users. For the present, marketing plans for the frequently discussed 8100 series have been shelved and a computer with Polish Notation similar to the B-5000 is reportedly ready for announcement but awaiting indication of stronger user acceptance of the Burroughs machine.

INVENTORY OF GOVT. COMPUTING

Published by the Bureau of the Budget earlier this year is a 127-page inventory of all adp installations estimated through the fiscal year ending June, 1962, for all branches of the federal government including various agencies, departments and the armed forces. A total expenditure for computing power is estimated by mid-61 at $442,317,000, and for FY-62, $497,743,000, an annual increase of 12.5%.

An estimated 328 main frames were acquired by the government during FY-61 and an additional 296 computers were scheduled for FY-62 installation. In FY-61, a total of 859 computers will be used during the year and 104 removed, providing 755 on hand as of June. For FY-62, it is estimated that 1,051 main frames will be used, 80 removed and 971 on hand.

In the purchase vs. lease breakdown, out of the 755 main frames on hand for FY-61, 640 were leased and 119 owned, an increase of 212 configurations leased and only 4 purchased.

(Next month, DATAMATION will publish a special compilation of the inventory indicating specific lines of edp equipment, and number of government installations.)

BENDIX COMPUTER TO SEEK GOVT. CONTRACTS

A major addition to Bendix Computer's western activity was announced last month by M.W. Horrell, general manager. Sales, engineering and production capabilities will be added to capture a segment of the lucrative, special purpose, military market. R.A. Sweet will head this effort while Paul Staderman continues to lead commercial and military sales of the G-15 and 20.

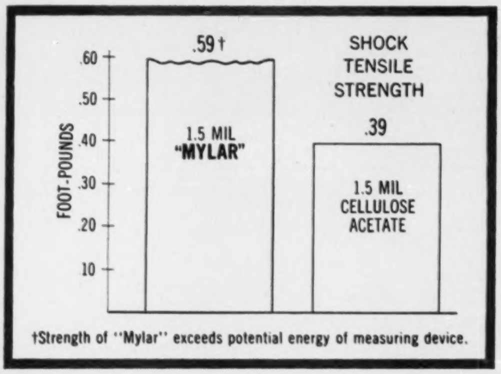
SPACE, an automatic programming package for the 20 including ALCOM, SPAR and COBOL, will be ready "sometime next year," while SNAP, a symbolic assembly program was made available late in July.

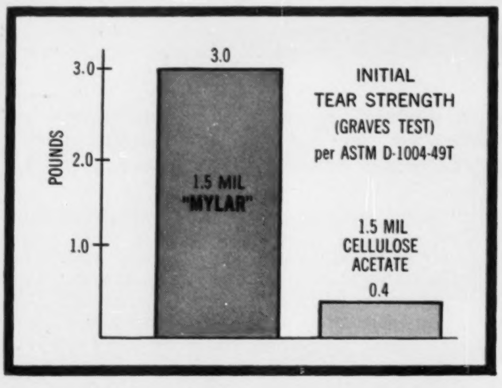
In advanced hardware, the G-25, a successor to the 15, has been presented to a number of users. Letters of intent are being accepted while orders are not, pending decision from the firm's eastern management.

YES, COLONEL! THERE IS A 9400

In DATAMATION's June issue, the Editor's Readout column may have conveyed the impression that Sylvania has completely withdrawn its 9400 system. Although the 9400 is not being marketed commercially, it is being offered to military users. Several contracts are reportedly in the house. The intent of the editorial was to focus only on gp, commercially available systems.

GUARD AGAINST DOWNTIME WITH RELIABLE TAPES OF MYLAR®



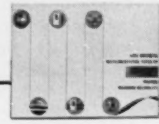


Every minute of downtime costs you dollars. That's why the reliability of your magnetic tape is so important. Tapes of Mylar*, resist breaking from sudden starts and stops since they have high shock-tensile strength . . . and they have 7 times the initial tear strength of acetate tapes.

"Mylar" adds to the reliability of playback. It resists the cupping, swelling and shrinking which can reduce intimate head contact and cause read/write errors. Age, storage conditions and repeated playbacks won't affect "Mylar" either.

The cost of the data . . . the cost of the equipment . . . the cost of time *all* demand reliability. Get it with tapes of "Mylar". Send coupon for free booklet of comparative test data and judge for yourself. Du Pont Company, Film Department, Wilmington 98, Delaware.

*Du Pont's registered trademark for its polyester film.



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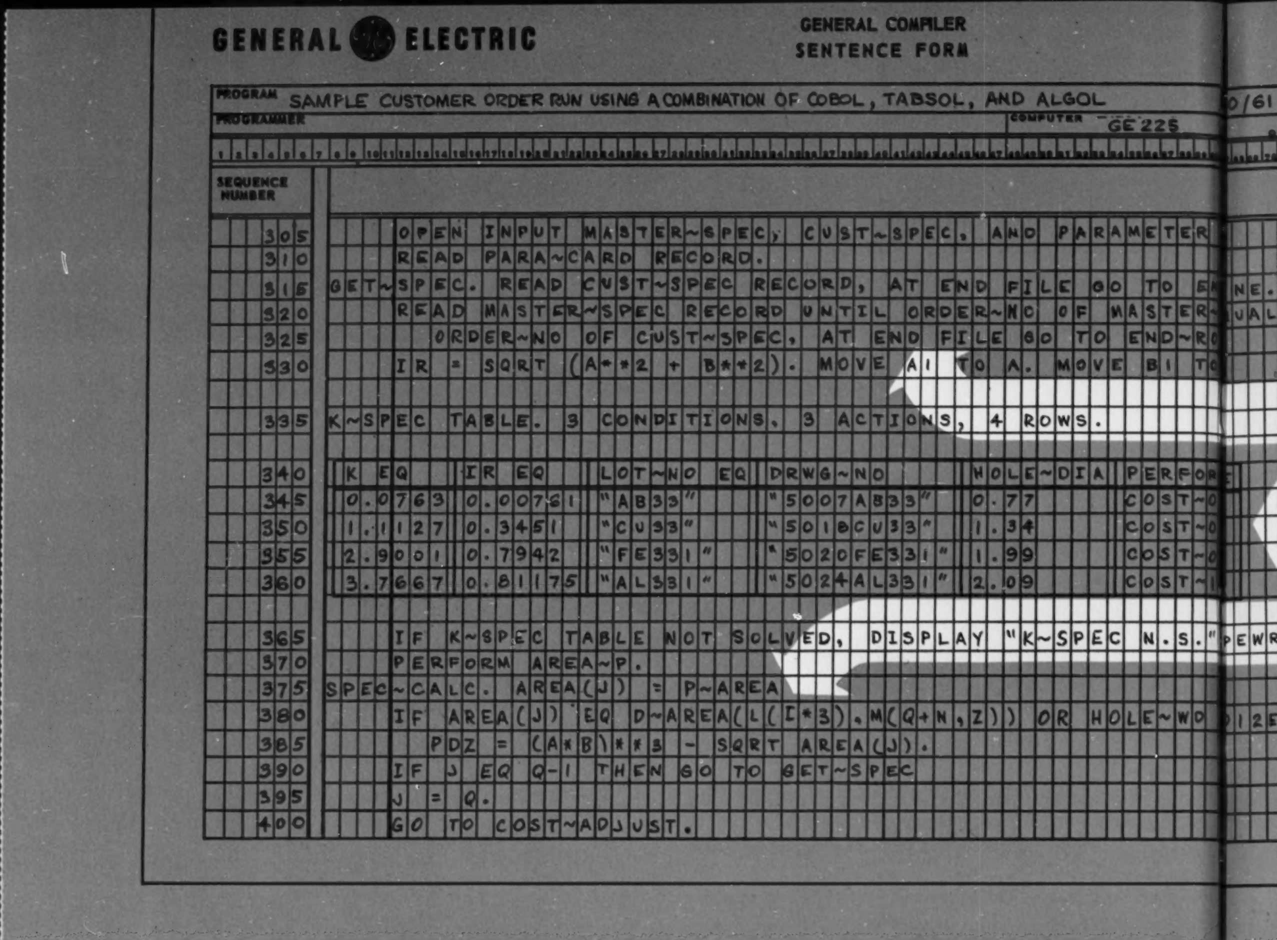


GENERAL ELECTRIC

GENERAL COMPILER
SENTENCE FORM

PROGRAM SAMPLE CUSTOMER ORDER RUN USING A COMBINATION OF COBOL, TABSOL, AND ALGOL

PROGRAMMER

COMPUTER GE 225

SEQUENCE NUMBER

```
305        OPEN INPUT MASTER~SPEC, CUST~SPEC, AND PARAMETER
310        READ PARA~CARD RECORD.
315  GET~SPEC. READ CUST~SPEC RECORD, AT END FILE GO TO E
320        READ MASTER~SPEC RECORD UNTIL ORDER~NO OF MASTER~
325             ORDER~NO OF CUST~SPEC, AT END FILE GO TO END~R
330        IR = SQRT (A**2 + B**2). MOVE A1 TO A. MOVE B1 TO
335  K~SPEC TABLE. 3 CONDITIONS, 3 ACTIONS, 4 ROWS.
340   K EQ     IR EQ     LOT~NO EQ   DRWG~NO         HOLE~DIA   PERFOR
345   0.0763   0.00761   "AB33"      "5007AB33"      0.77       COST~0
350   1.1127   0.3451    "CU33"      "5018CU33"      1.34       COST~0
355   2.9001   0.7942    "FE331"     "5020FE331"     1.99       COST~0
360   3.7667   0.81175   "AL331"     "5024AL331"     2.09       COST~1
365        IF K~SPEC TABLE NOT SOLVED, DISPLAY "K~SPEC N.S."
370        PERFORM AREA~P.
375  SPEC~CALC. AREA(J) = P~AREA
380        IF AREA(J) EQ D~AREA(L(I*3).M(Q+N,Z)) OR HOLE~WD
385             PDZ = (A*B)**3 - SQRT AREA(J).
390        IF J EQ Q-1 THEN GO TO GET~SPEC
395        J = Q.
400        GO TO COST~ADJUST.
```

GECOM...A UNIQUE CONCEPT IN C

now available in the GE 225 ... and future General Electric general-purpose computers.

- processes COBOL, ALGOL and TABSOL*
- all problem statements easily read and understood
- extended usage... re-programming unnecessary
- programs produced faster... more efficiently

GECOM—the first truly GENERAL COMPILER SYSTEM—introduces a fresh, versatile approach to computer communication. Developed for the GE 225 computer, the GENERAL COMPILER *makes available all of the various proved programming techniques in one consistent, compact package.* No longer is it necessary to learn a dozen different programming systems to handle a full range of jobs effectively—each job is approached in *exactly the same way,* be it formula evaluation, a sort, or even a payroll. The language for describing any run is *consistent,* operating procedures and programming are *standard,* and documentation is readable and easily *understood.*

*A General Electric Trademark

THE GENERAL COMPILER PROVIDES—

A FAMILIAR LANGUAGE STRUCTURE—Problems need not be stated in machine code. The GENERAL COMPILER processes English language statements (COBOL), Algebraic expressions (ALGOL), and Structure Tables (TABSOL). It permits you to use all or any one of the computer languages... as your needs require. Still you have available the capability to expand, use other languages and new techniques as your needs change.

A PROVED, ACCURATE CODER—Data Description and Problem Logic may be written in one, two, or a combination of the available languages producing a machine program of efficient, effective coding. Since the machine coding is derived directly from the logic of the problem statement, it is only at the logic level that debugging may have to be done.

A STANDARDIZED, UNDERSTANDABLE DOCUMENTATION—Because GENERAL COMPILER problems are written in familiar languages, they can be easily read and under-

editor's readout

THE WEED OUT!

Still prognosticating a dim future for the staying power of computer manufacturers, a generous number of market analysts have gathered and garnished their statistics with perfectly reasonable logic.

Their basic contention: although the market for hardware will continue to prosper, it is clearly impossible for the present number of computer manufacturers (a) to survive the substantial investment required for advanced technology, particularly where there is no strong alternative market to absorb heavy annual losses (i.e., t.v. sets or electric razors); (b) to maintain satisfactory field support and software backup; (c) to mass produce medium and large scale systems, and finally (d) to compete with a large flock of comparable firms, all offering basically the same equipment for "a narrow, vertical market."

Their conclusion: "the weed out" will surely take place within a handful of years with three or four firms dominating the field and the remainder (if they insist on remaining) accepting a minute fraction of the market.

In support of their forecasts, market analysts have been confronted with one irksome problem, namely, *all visible evidence of late, has indicated they are dead wrong in both contention and conclusion.*

Despite the fact that a number of forecasts have pointed to small companies as the first to expire, it is precisely in this area where some of the real strengths of the industry have appeared. Not only have these "weenies" persisted in selling their machines, but they continue to announce new hardware of sizeable proportions.

Perhaps the best example is Control Data Corp. with its 160A, 1604, soon-to-be-announced 924 and Stretch-class 6600. Packard Bell Computer is another case in point where rumor of corporate lack of optimism in its computer division will find little support when PB announces its 350 late this Fall. Computer Control Corp.'s forthcoming DDP and El-tronics' ALWAC IV, a solid state entry to be ready next year, are further indications that the staying power of the small company is not to be underrated.

Having recently completed its 100th 7090 installation and with a flock of small to medium-sized contenders rolling off its production lines, there is little doubt that IBM will continue as the giant in the computer industry. But companies such as RemRand, well-known for their ability to turn an advantage into a loss, have shown promising signs of twisting the bit in the opposite direction. Surprises are also forthcoming from RCA with research in high speed circuitry through diode memory.

As for others: Burroughs is very much in the solid state field with the 5000, 270 and forthcoming announcement of the 260. Philco has stuck neatly to its 2000 series improving speeds with the 212. Advances in high speed tape units and mass storage devices are also under development by Philco.

Sales of the Honeywell 400 have been excellent and FACT although embarrassingly late, reportedly is now ready to fly on the 800. Some technological rabbits may also be pulled out of General Electric's new Sunnyvale hat.

In general, the most pessimistic news for computing market analysts is the obvious fact that within the last three years, no one has left the field. There are of course, some trends which have influenced the health of the industry; namely, a tempering of the early fever of the sales pitch which could easily have driven a company or two into trauma and ultimately out of the computing business. Also, there is a maturing realization of the need for long term investment coupled to a gradual shift in the purchase vs. rental balance providing smaller firms with a more encouraging, earlier dollar return. Finally, the field itself has expanded from what may have been a narrow, vertical base of a decade ago, to a rapidly growing tree sprouting numerous horizontal branches such as process control, real time control, and many new areas of general purpose application.

It would seem therefore, that "the weed out" is hardly a frightening prospect except that as the prophecies do not bear fruit, the job security of the prophesiers may be inversely effected.

A PERSPECTIVE

by HARRY D. HUSKEY, President, Association for Computing Machinery

Since its founding in 1945 at a meeting held at Massachusetts Institute of Technology, it has been customary for Association for Computing Machinery national conferences to be held on university campuses. This year will see a departure from this procedure with the 16th annual meeting being held at the Statler-Hilton Hotel in Los Angeles. At the first meeting a Bush and Caldwell electronic differential analyzer was demonstrated; there were digital computers in various stages of development at that time but none were completed. At our meeting this year, full-scale exhibits will be a part of the conference schedule for the first time and a distinguished collection of small-size computers and peripheral equipment for high-speed computers as well as auxiliary devices and services will be shown.

The past 16 years have been eventful ones as this most dynamic field has rapidly advanced its technology in hardware and programming systems and received widening uses in almost all fields of commerce, military, government and academic life.

The ACM, with now more than 8,000 members including representatives from 24 countries, serves its own sciences and at the same time functions to bridge the gap between other disciplines and the general public. The conference this year is an example of the many interests found within the framework of the society. There are strong sessions on the basics of computer use — languages and numerical analysis, as well as on an increasing number of specialized fields such as medical and business data processing. Aspects such as the management of computer installations and programmer training are also covered.

In a recent membership survey it was discovered that 19% of the members are in the "pioneer" category of ten years or more in the field while 35% have been in it four years or less. The bringing together of the seasoned member with the comparative newcomer is one of the most valuable aspects of the conference. Experts are available for information exchange, informally or formally, and the popular Halls of Discussion, where those interested in a specific area of development can gather together and brain-storm, share new ideas, present problems and talk in meeting rooms where there is a starting time but no official termination, are another valuable contribution to the aims of a technical society.

We look forward to this year's conference as an outstanding step forward in fulfilling the purposes of ACM as regards its membership and its responsibility to other areas of our national life.

Dr. Harry D. Huskey — President,
Association for Computing Machinery
Professor of Mathematics and Electrical Engineering
University of California at Berkeley

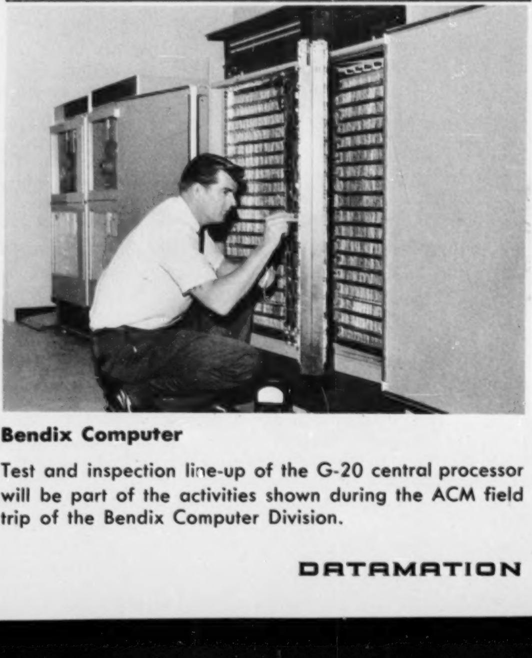
16th ANNUAL

ASSOCIATION FOR COMPUTING MACHINERY
ACM
FOUNDED 1947

CONFERENCE and EXHIBIT

SEPTEMBER 5th—8th, 1961
STATLER HILTON HOTEL, LOS ANGELES

HARRY D. HUSKEY



Bendix Computer

Test and inspection line-up of the G-20 central processor will be part of the activities shown during the ACM field trip of the Bendix Computer Division.

THE PROGRAM: highlights & expectations

This year's program may possibly represent the most outstanding communication of computing knowledge that has ever been presented at an ACM conference. The amount of significant information to be communicated has resulted in a heavily-scheduled three and one-half day conference extending into two special evening tutorial sessions on ALGOL and COBOL.

The opening session on Tuesday afternoon, Sept. 5, is perhaps the most unusual feature of the program with brief progress reports from leaders in various aspects of computing such as:

A. S. Householder, Oak Ridge National Laboratory, reporting on the Gatlinger Matrix Conference, and **Franz Alt,** National Bureau of Standards, describing new developments in Automatic Language Translation.

These papers will cover known work in the field as well as new developments, and serve as a general stimulus for the balance of the conference.

Panel sessions conclude the first afternoon's activities with University Education in the Computer Era, chaired by George Forsythe of Stanford University; JUG Sponsored Discussion of Operating Systems for Large Scale Computers, chaired by Frank Engel, Westinghouse Electric Corp., and Numerical Control of Machines, chaired by S. M. Matza, IBM.

Ten invited papers will be likely contenders as the principal highlights of the conference, and because of their importance, will be presented in plenary, non-parallel sessions. Included in this group are:

R. W. Hamming, Bell Telephone Laboratories, The Mechanization of Science; **Ascher Opler, Computer Usage Co.,** Prospects for Automatic Programming; **Richard Bellman, The RAND Corp,** Mathematical Experimentation and Biomedical Research; **Robert D. Richtmyer, N.Y.U.,** Developments of Methods for Fluid Dynamics Calculations; **Alan J. Perlis, Carnegie Institute of Technology,** It's Easy to Write Compilers; **Edward F. Moore, Bell Telephone Laboratories,** Is Artificial Intelligence Just Around the Corner?

The response to contributed papers has resulted in 145 submissions from which the program committee selected 74 to comprise 18 scheduled sessions. Their composition indicates a trend toward greater emphasis on business data processing and information handling with less hardware discussion. Outstanding invited papers and their authors include:

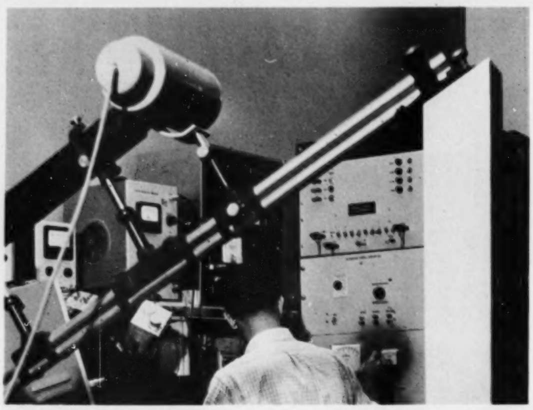
Ascher Opler and Myra Gray, Computer Usage Co., Design of a Multiprogrammed Algebraic Compiler; **W. Orchard-Hays, C-E-I-R, Inc.,** The General Program of Computing Languages: Their Nature, Function and Translation; **Saul Rosen, Consultant,** ALTAC, FORTRAN and Compatibility; **Edward A. Feigenbaum, Univ. of California,** and **Herbert A. Simon, Carnegie Institute of Technology,** Forgetting in an Association Memory; **Jean E. Sammet, Sylvania Electric Products, Inc.,** A Definition of the COBOL Procedure Division Using ALGOL Metalinguistics.

Also: **F. J. Corbato, M.I.T.,** A Technique for Precise Computation with Factorials in a Digital Computer; **Thomas B. Steel, Jr., S.D.C.,** The Foundations of a Theory of Data Processing; **Philip Wolfe, RAND,** The SCEMP Project; and **J. H. Veyette, Jr.,** IBM, Impact of Information Retrieval on Corporate Structure.

For the third successive year, there will be "Halls of Discussion," largely sponsored by the special interest groups of ACM. One session, Digital Computing in Medicine, will be sponsored by the Bio-Medical Information Processing Organization and another, Dividing the Information Retrieval Chores Between Human and Non-Human Automata will be led by Herbert R. Koller, U.S. Patent Office.

Copies of the conference proceedings containing 4-page summaries of papers will be available at time of registration. As a stimulus to the method of presentation, a committee headed by C. D. Madden will elect three judges to evaluate each contributed session on a standard score-sheet including the speakers' delivery, use of visual aids, question response, etc. After the conference, awards will be presented to the speaker(s) judged most outstanding.

FIELD TRIPS



National Cash Register

High density storage through optical readout of magnetically recorded data is a problem explored at NCR's Electronics Division.

System Development Corp.

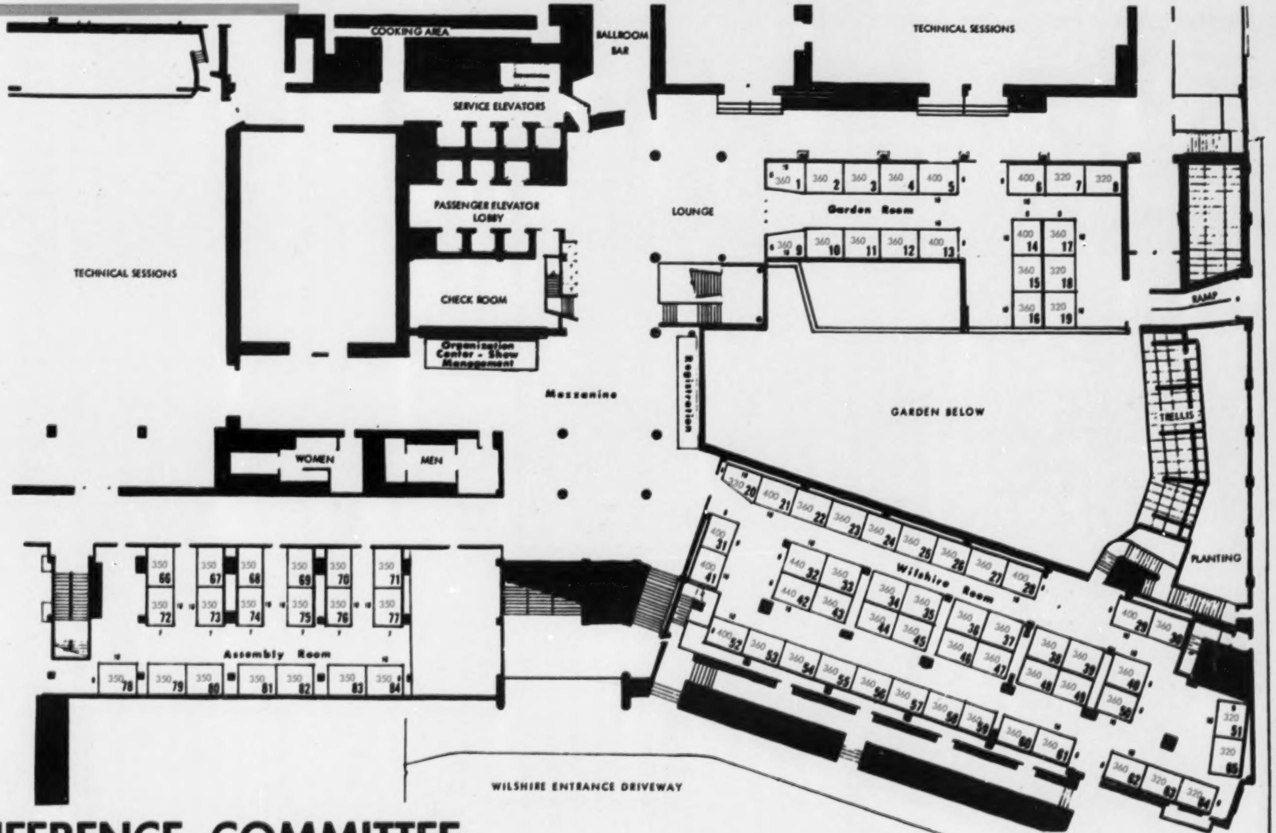
The Philco 2000 undergoes installation checkout at System Development Corp.'s new Systems Simulation Research Laboratory.

LIST OF EXHIBITORS

Exhibitor	Booth Numbers
ACADEMIC PRESS, INC.	64B Wilshire
ADDRESSOGRAPH-MULTIGRAPH CORP. Scale model of A-M EDP system series 900; data punch for decentralized data gathering; optical code data recorder, reader and embosser; multilith offset and copy sorter.	57, 58, 59, 60, 61 Wilshire
AMERICAN SYSTEMS, INC. Magnetic thin film shift register.	19 Garden
AMPEX COMPUTER PRODUCTS COMPANY FR-400 and TM-2 magnetic tape units; core memories and buffers.	38, 39 Wilshire
BENDIX COMPUTER DIVISION Operating G-15, magnetic tape unit and graph plotter; peripheral G-20 hardware; models of G-20 and G-15.	9, 10 Garden
BURROUGHS CORPORATION Compact card reader and magnetic tape unit peripheral to B5000 Information Processing System; scale models of B5000 in typical and maximum configurations; B5000 modules and memory planes.	1, 2 Garden
CALIFORNIA COMPUTER PRODUCTS Digital incremental X-Y recorder; magnetic tape plotting system.	50 Wilshire
C-E-I-R, INC. Computer services, programming and consulting in mathematics, OR, etc.;	31, 41 Wilshire
CLARY CORPORATION DE-60 Computer; DE-60M mobile computer; add-punch equipment.	65 Wilshire
COMPUTER CONTROL COMPANY Digital Data Processor; coordinate converter computer; data translator; core memories, transistorized modules, code bar switch.	62, 63 Wilshire
CONTROL DATA CORPORATION CDC 160-A computer with paper tape in/out, magnetic tape and console typewriter.	21, 22 Wilshire
DASHEW BUSINESS MACHINES, INC. Printapunch for source data gathering; manual and high speed code punchers and embossers.	40 Wilshire
DATAMATION, F. D. THOMPSON PUBLICATIONS, INC.	6 Garden
DATANAMICS, INC. Source Data Recorder.	3 Garden
DIGITAL EQUIPMENT CORPORATION PDP-1 Digital Computer; circuit, laboratory, classroom and training modules; memory test equipment.	27, 28 Wilshire
THE DIGITRAN COMPANY Digital switch, counter, pulse totalizer.	51 Wilshire
EDP WEEKLY	64A Wilshire
ENCYCLOPEDIA AMERICANA Encyclopedia; min-max teaching machine; Harvard Classics.	26 Wilshire
ENCYCLOPEDIA BRITANNICA AND GREAT BOOKS	42 Wilshire
FERRANTI ELECTRIC,INC. Animated display of ATLAS Computer; model of core storage.	4, 5 Garden
GENERAL DYNAMICS/ELECTRONICS Demonstration of S-C 1090 direct view display for computer output and monitoring.	29, 30 Wilshire
IDAHO MARYLAND INDUSTRIES INC. Elevated computer flooring; magnetic heads; memory storage drums.	43 Wilshire
INTERNATIONAL BUSINESS MACHINES IBM 1620 with card input/output; constrained hand lettering reader; teleprocessing.	14, 15, 16 Garden
LIBRASCOPE DIVISION, GENERAL PRECISION, INC. Libratrol 1000 process control computer; Federal Aviation Agency's central data processor (L-3060); various airborne and military general purpose computers.	12, 13 Garden
MAGNAVOX RESEARCH LABORATORIES Magnacard 4-drum handler and control unit; circuits, circuit boards; data sampling relays.	7, 8 Garden
MONROE CALCULATING MACHINE COMPANY, INC. Monrobot XI	17, 18 Garden
THE NATIONAL CASH REGISTER COMPANY NCR C-315 EDP system; CRAM random and sequential access memory; 2,000 card per minute reader.	34, 35, 44, 45 Wilshire
THE PACIFIC TELEPHONE AND TELEGRAPH CO. The role of communications equipment in data processing.	52, 53, 54 Wilshire
PHILCO CORPORATION, GOVERNMENT AND INDUSTRIAL GROUP Philco 2000 large scale EDP system.	23, 24, 25 Wilshire
RECORDAK CORPORATION Recordak-Dacom system, ultra high speed computer output recorder; high speed data retrieval.	46, 47 Wilshire
SERVICE BUREAU CORPORATION Programming and computer services; computer processing; PERT/PEP.	11 Garden
SOROBAN ENGINEERING, INC. GP-2 paper tape perforator and FRA-1 paper tape reader; various tape readers, keyboards, Computeriters and tape preparation systems.	48, 49 Wilshire
SPACE TECHNOLOGY LABORATORIES, INC. Role of the Computation and Data Reduction Center in space exploration.	32 Wilshire
SYSTEM DEVELOPMENT CORPORATION Three dimensional model of SDC's concept of system development; model of system simulation research laboratory.	36, 37 Wilshire
TELETYPE CORPORATION Data communication equipment; BRPE 110 paper tape punch, CX 110 tape reader; model 28 tape punch set.	55, 56 Wilshire
UPTIME CORPORATION Punched card Speed Reader 2000; control and checking electronics.	33 Wilshire

EXHIBIT AREA

EXHIBIT AREA



1961 CONFERENCE COMMITTEE

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9 awards presented for

EDP HARDWARE DESIGN AT '61 WESCON

The computer industry and perpherial EDP areas have attracted much attention by winning nine of twenty-three merit selections in the Industrial Design Competition at the 1961 WESCON, scheduled for August 22-25 in San Francisco's Cow Palace.

Further judging will determine up to five "Awards of Excellence" to be announced the opening morning of WESCON.

Included among the selections that are connected with data processing are: Consolidated Electrodynamics Corp.'s magnetic tape degausser used for automatic bulk erasure of magnetic tape; Data-Stor Division of Cook Electric Co.'s digital magnetic tape transport; and IBM's 1011 data transmission terminal for transmitting prepunched or variable data over a telephone and the 1011 paper tape reader.

Also included among the companies cited for excellence are: Autonetics Division of North American Aviation, Inc. for their high speed tape reader and precision punch; the Computer Division of Packard-Bell Electronics Corp. for its MT-1 module tester; Precision Instruments Co. for its recorder-reproducer and a continuous tape loop multichannel simulator; and Sylvania Electric Products, Inc. for its 9400 large scale general purpose digital computer.

The technical program offers a number of computer-oriented sessions. Session 3, Tuesday, August 22, is entitled High Speed Logic, and will be conducted at 10 a.m. in Room C. Topics of the papers will include "Relationships Between Device and System Design Factors in UHF Computers," "ASI – A High Speed Anti-Saturation Inverter Logic Circuit," and "A Tunnel Diode – Tunnel Rectifier, 15 Nanosecond Memory."

Session 7, scheduled for Room B at 2 p.m., is entitled Solid State Devices. Papers include "Superconductor Solenoids," and "Parametric Quartz Amplifier."

Session 8, Computer Applications, will be conducted at 2 p.m. in Room C. Papers planned for presentation will be "Plato: An Automated Teaching Device," "The User Looks at the Information Storage and Retrieval Field," and "An Advanced Digital Data System for Use in Nuclear Reactor Development."

Thursday, August 24, will include session 23 on Nanosecond Techniques at 10 a.m. in Room C. The papers given will be "Nanosecond Pulse Measurements," "A Triggered Nanosecond Pulsed Light Source," and "Analysis and Measurement of Phase Characteristics in Microwave Systems."

Session 38 on Friday, August 25, will concern Computer Theory and will be presented at 2 p.m. in Room C. The papers will include "A Decision Theoretic Approach to Machine Learning and Pattern Recognition," "Diode and Transistor Logic in Synthesis of Unit-Time Arithmetic Circuitry."

Included among field trips of particular interest in the field of information processing is a tour of the computer and microelectronics laboratories at the Stanford Research Institute. Visitors will hear the SRI technical staff discuss the neuristor, all-magnetic logic techniques, microelectronics, and pattern recognition.

Demonstrations of magnetic logic circuitry, a small all-magnetic arithmetic unit, and various storage techniques will be presented. The tour is planned for 1 p.m. Thursday, August 24.

the SC 1090

"OFF-THE-SHELF" DISPLAY CONSOLE

To be priced under $30,000, a standardized "off-the-shelf," direct view, 19" display console, designed for monitoring digital computers, both on and off line, has been announced by the Information Technology Division of General Dynamics/Electronics, San Diego.

The new data processing tool will be introduced for the first time at WESCON, Aug. 22-25, and shown again at the ACM Exhibit, Sept. 5-8.

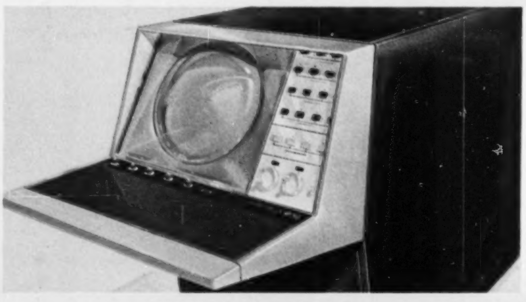
Dubbed the SC-1090, one of the console's primary functions will be in command decision for man-machine information systems such as air traffic control, information retrieval, and automatic process control.

Although the S-C 1090 is designed as a complete unit, optional equipment such as an internal test routine, input register, level converters, internal storage of complete display frame, vector generator expansion and off-centering, and category selection are also available to adapt the unit to specific data system requirements.

In operation, the console displays highly legible characters, symbols and vectors on the screen of General Dynamics' Charactron shaped beam tube. Since this function requires only a few microseconds for a single character, the unit displays well over 1000 characters with high resolution. The S-C 1090 may also be used as a laboratory tool for investigation of display parameters. For example using the line writing mode of operation, typical radar scans can be presented and evaluated against purely symbolic data or various combinations of these two forms.

In addition to constant monitoring of digital computer outputs, the S-C 1090 can display a significant block of information in storage, as well as the contents of data registers in the computing section of the system. This "quick" search of the complete stored program makes possible more rapid debugging of new programs without resorting to a mechanical printout of data.

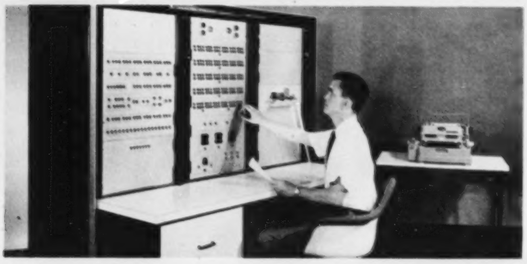
Since the face of the beam tube is 19" in diameter, it is possible to present data in pictorial or graphic formats, geographic surveillance formats, as well as that of texts and tables. The console is 66" long, 32" wide, and 45" high. Availability is approximately six months.



CIRCLE 109 ON READER CARD

THE DIGITAL DATA PROCESSOR

a gp entry from Computer Control



As its first entry into the general purpose computer market, Computer Control Company has announced the development of a new, medium size, high speed machine, the Digital Data Processor (DDP-19), to be offered for the real time processing of engineering data.

The prototype DDP-19 is in operation in the engineering laboratories of a leading aircraft manufacturer. Industrial design and programming development of the pre-production model is now under way at 3C's Western Division in Los Angeles.

DDP-19 specifications

Computer Control's experience with special purpose computer applications indicated a substantial requirement for high speed computers in the 19 to 25 bit range. The DDP-19 is a 19 bit machine with a 5 microsecond core storage of 4,096 and 8,192 words. A second generation 25 bit machine, the DDP-25, is now under design.

The DDP's, including peripheral equipment, are in the price range of $115,000 to $400,000. These machines are single address, parallel, binary computers. Memory access time is 2.5 miroseconds. A complete minor cycle is performed in five microseconds. A shift instruction can be read from memory and completed in one minor cycle. An add or subtract instruction can be read, the operand taken from memory, and the result made available in the arithmetic unit in two minor cycles. An average multiply is performed in 36 microseconds and divide in 45 microseconds.

applications

Computer Control Company has designed the DDP-19 and is developing the DDP-25 for three engineering applications. The first is for real time simulation problems involving hybrid analog and digital equipments and simulation problems including sub-systems; second, as a control computer for the precision tracking of high speed targets; and third, as an application for real time test data acquisition and the presentation of scaled and digitally filtered results. Additional computational capacity permits complex operations and the control of sampling rates based on new or semi-processed data.

The word length of the DDP-19, 19 bits, was chosen to permit ingle precision computation to satisfy the accuracy and range requirements of the above applications. This word length also provides a single memory reference (5 microseconds) for both command and operand address to contribute to the DDP's speed.

input-output features

Up to 16 input or output channels are available under program control. Commands are included which provide: direct transfer to or from specified input-output registers from or to any memory cell, and transfer to or from the arithmetic unit from or to any input-output register.

Each input-output unit may be operated in either a "busy" or "demand" mode. In the "busy" mode a busy signal is generated. An interlock is provided so that if an input or output demand is made when the device is not ready to give or receive information, the computer will wait until the device is ready. This status of any input or output unit may be interrogated by the program to avoid unnecessary delays.

In the "demand" mode the input-output unit indicates an unconditional jump to a pre-selected memory cell at the completion of the operation in process. Provision is made for return to branch point on command. Priority of input-output units is established by the program.

A buffered input-output channel not under program control is available with the standard DDP. This fully buffered channel permits maximum input-output with a minimum interference to the computations. This channel provides a word transfer rate up to 200 kc and may be used for any high speed data transfer. Additional buffered channels can be provided.

The DDP-19 has a high speed paper tape input at 500 or 1000 cps and a Flexowriter output. Large and medium width line printers are to be available. 3C offers with the DDP input-output devices including magnetic tape in a format compatible with the IBM 727 and IBM 729, a 110 cps paper tape punch, a 400 cpm card reader, and a variety of analog input-outputs.

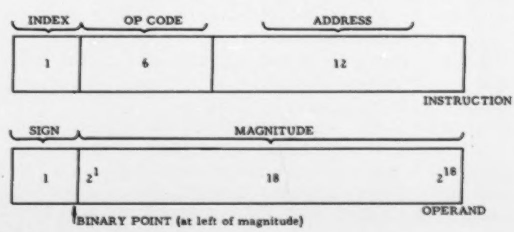
programming aids

Standard subroutines are being programmed in fixed point, floating point and double precision. Also featured are a linear algebraic subroutine which performs matrix inversions and simultaneous equation solutions and a compiler-assembler routine.

For many years, a manufacturer of digital modules and special purpose digital systems, 3C's first gp entry may prove an interesting contender for the medium size computer market.

CIRCLE 112 ON READER CARD

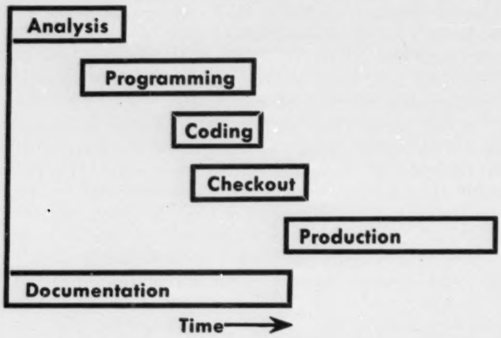
DDP-19 WORD FORMAT



DOCUMENTATION— KEY TO PROMOTION

by ROBERT L. PATRICK, Computer Specialist
Manhattan Beach, Calif.

Time Phasing Chart Showing The Six Major Areas of Problem Solution.



The above idealized chart depicts the time phasing of the six major areas necessary to the successful solution of any problem. These areas exist to some greater or lesser extent for all problems solved on any automatic equipment. The portion of effort spent in each area varies somewhat from the "business" to the "scientific" tasks, but all six areas do exist in some proportion in every case.

Suppose we were to interview any programming supervisor (or other pedestrian) on the subject "Why do you have your programmers document?" He would immediately rattle off the following reasons:

1. "Since so few programs are truly 'one shot,' we document to retain our engineering investment.

2. "We also document for historical purposes so we can, posteriorly, figure out why a math model performed in a given way.

3. "For large jobs, we found that documentation is the only way to be assured of success when we go to put the blocks together. For large jobs, we found that just documentation is not sufficient but that parallel documentation is required as shown in the Time Phasing Chart."

4. Upon pressing further, he says that he also documents for protection. "In case of a conflagration followed by a legal battle with the customer or ultimate user, the guy with the records usually wins."

5. "Sometimes government contracts *specify* that documents on the programming and math models must accompany the hardware as contractual items.

6. "As a programming supervisor and responsible for several individual projects, it's very difficult to know exactly what is going on all the time without extended periods of visitation and note taking. In order that I am able to answer status queries from management concerning the tasks over which I have direct line responsibility, I call for reports from the project leaders. In this way my project files adequately document the progress (or lack of it) of the project. This also gives line supervisors the opportunity to call deficiencies to my attention so that I may assist.

7. "Documentation and status reports also provide insurance against personnel turnover or reassignment in our dynamic organization."

8. As an aside, he may indicate that documentation, particularly in the form of a formal engineering report, helps supply justification for next year's budget. "Some industrial societies believe in 'Publish or Perish'."

Over lunch, and perhaps after the first martini, if you ask him *what* constitutes "documentation," he would probably indicate most of the following points:

1. "A problem statement, usually drawn up by the lead analyst and the customer, which defines exactly what task they intended to solve when the project started."

2. "Some process charts which indicate how the analyst approached the problem from an overall view. These show what major programs are required to accomplish the task, what input is required for each, and what output is expected from each. Process charts tie down the interfaces between the major blocks of the program."

3. "The program itself is also a key component in documentation. Although source decks for compilers read fairly well (and machine code can be made to read fairly well with enough comments and remark cards), there needs to be, in addition to the up-to-date punched source deck and its accompanying object (or absolute) deck, some written material describing the deck. A second person unfamiliar with the code would want to know how the process chart was implemented; how the symbols were assigned (if this were done in some logical manner); what assumptions are buried down in the code; what the limitations of the program are; and what extensions were provided for in the code, but not completed. Sometimes far sighted programmers will provide linkages for additions to the code, but not supply the additions themselves. Naturally, these would be documented in the written material."

4. "Another part of the programmer's documentation would be special instructions just for programmers telling how, in detail, the source deck is built up for compilation (or assembly). This would indicate just where certain values are to be found in the real world, what symbolic names these values are assigned, and where these symbolic assignments should be placed in the source deck."

5. "Furthermore, there would, for large jobs, be additional instructions to programmers telling exactly how the final object program was to be obtained and maintained. This section would define how the object code for this task was processed through the operating system in order that a production master program tape could be obtained

and verified. This would be particularly important if the task consisted of several separate passes and the final object program was the result of a series of cascade compilations (or assemblies) whose output was then processed by a master tape maintenance program."

6. "There would, of course, be an entirely separate section written for the immediate user telling exactly how data was to be prepared, recommending checking steps on the data prior to its entry into the computer, and specifying what input editing was built into the computer program."

7. "Last but equally important, would be instructions to the production computer operator. We build most of our operator instructions right into the production programs. They are presented by the program on the console typewriter (or line printer) at the appropriate time. Even so, there are some things that must be set down for the operator in typewritten form. A couple of well thought out sheets do wonders toward recovering from an unexpected error."

Finally, if we asked this supervisor *who* documents, we would find out that this is usually delegated to the project leader. It is also his responsibility to set standards of excellence and to pass on the adequacy of submissions from the working level (in the case of a one-shot solo program where the project leader and the working level are one and the same, the supervisor usually gives up!).

If we then proceed to sample the working level supervisors and ask the same questions, we usually get approximately the same answer to the last two, but when we ask the working level project leader *why* he documents, we are advised, "I document because *he* (the programming supervisor) tells me to."

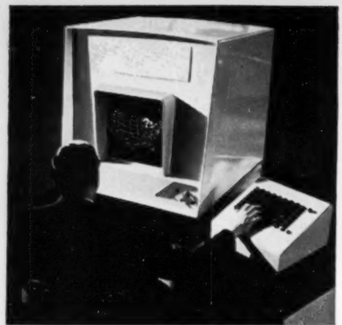
Having concluded our interview and returned to our cloister, we conclude that the points that were mentioned are obvious, valid, and necessary, but we are suddenly struck by the fact that there are several points that were unmentioned by either the supervisor or the leader. Musing further, we are amazed that these oversights provide an unexploited motivating power that should not be allowed to go to waste.

A. The documenting function is an excellent ingredient for a course of on-the-job-training for junior programmers. Writing the documents from source material provided by the workers teaches a junior programmer *current* practice which no book, school, or seminar could hope to accomplish. Furthermore, it does this in the confines of your own shop using your own operating system in your way.

B. *Any programmer worth his salt should be interested in self improvement.* Parallel documentation, including a personal informal daily diary, would allow him to sit back after the battle is over and abstract from experience. He could isolate events and decisions that contributed to his success so that they could be repeated. He could isolate events and decisions that contributed to his downfall so that they could be avoided.

C. A set of documents covering the topics noted above constitute a representative sample of a project leader's work. This sample might prove invaluable in obtaining a much desired assignment from present management, or be a fine adjunct to a resume when seeking new employment.

D. Last, good current parallel documentation, covering the project you are on, may be the key to *your* getting an assignment *you* desire. Both the opening and good past performance are necessary to be considered for promotion, but these alone are not sufficient. If you are married to your current assignment, you probably cannot be spared for some new romance. On the other hand, if you have trained an understudy and have good current documentation, you are available.



"need to know now" applications of the RD-900 Random Access Storage and Display System.

The RD-900 provides a random access file of up to 495 million, or more, bits with access to information in less than 3/10 of a second. It is adaptable to virtually all existing computer systems, or may be used as an independent random access storage and display unit. The display device is a high resolution, flicker-free, 21″ direct view storage tube capable of exhibiting up to 12,800 characters or symbols. Alphanumerics, arbitrary or abstract symbols, graphs, charts and maps may be displayed.

Its primary application is any situation where instant access and simultaneous display of volume data are required.

Typical applications are illustrated.

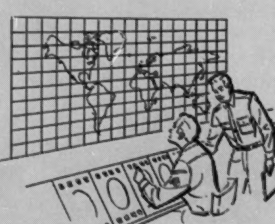
1. **Account Servicing** . . . for banks, utilities and other service organizations. Customer inquiries may be answered in seconds without interrupting the normal accounting cycle.
2. **Air Traffic Control** . . . where accurate and vital information is required at a moment's notice . . . allows alpha-numeric display superimposition on chart or map indicating actual aircraft position.
3. **Ticket and Reservation Control** for rail, ship, plane, hotel and associated industries . . . would eliminate overselling of space . . . with graphic presentation, passengers could actually see which cabin, seat, or room was being assigned.
4. **Immediate Stock Information** to brokerage houses, including current transactions, past transactions as well as trends that establish buy or sell situations.
5. **Military Command Control** situations where a large volume of data must be digested and decisions based on such data must be reached within an extremely critical time period.

Account Servicing

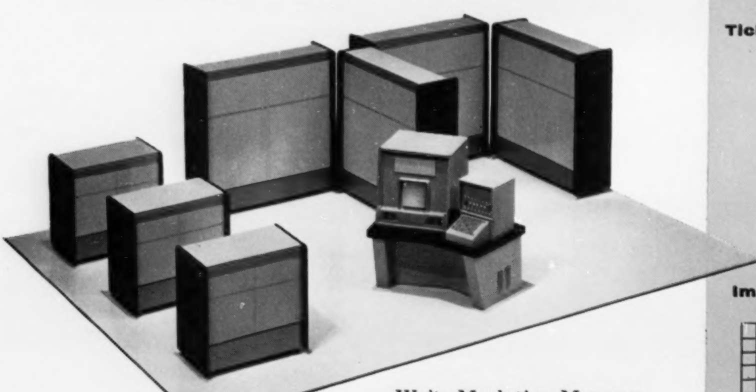
Air Traffic Control

Ticket and Reservation Control

Immediate Stock Information



Military Command Control



Write Marketing Manager, Computer Products Division for complete information.

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DATAMATION *news briefs*

ACM TO FORM NATIONAL BUSINESS DP GROUP

A National Committee for Business Data Processing, sponsored by the ACM may be formally organized at ACM's forthcoming September conference in Los Angeles.

Purpose of the new committee will be to upgrade the professional level of work of association members whose interests include business theory, operations research, management gaming, simulation, and forecasting techniques, as well as the more classic dp functions generally associated with the controller's office.

Several local chapters of ACM have already organized special interest groups in this area following recommendations established at a recent ACM organizational meeting.

SYLVANIA REVERSES SPEECH RECOGNITION

An automatic speech recognition system utilizing a digital computer to convert a set of numbers into a voice tape recording is under development at the Applied Research Laboratory of Sylvania for the Rome Air Development Center, New York.

Since automatic speech recognition is essentially a translation of human speech to a mechanistic language that can be operated upon by a computer, it is anticipated that this process can be successfully reversed, permitting translation of the machine language back into human speech.

Project engineer H. J. Manley is testing this method by introducing a tape recording of the human voice into a computer where the sounds are first mathematically analyzed and then resynthesized from the resulting numbers on a sound recording. By playing the two recordings in turn, the fidelity of the synthesized recording to the original will be a measure of the project's success.

ASA NATIONAL CONFERENCE READY FOR HOUSTON

Efforts toward the development of a common business oriented language as well as progress of domestic and international standardization work in the dp field will be reported at the American Standards Assoc.'s 12th National Conference, Oct. 10-12, in Houston, Texas.

Arranged by the Office Equipment Manufacturers Institute, the morning session on October 11 will deal singularly with data processing, its problems, benefits and the need for standardization work. I. C. Liggett, director of systems standards for IBM and chairman of the ASA X3.2 subcommittee on coded character sets and standard data format, will be session chairman.

H. S. Bright, engineering director of OEMI and chairman of the ASA X3 sectional committee on data processing, will open the session with a status report on the sectional committee's efforts toward data processing standards for the U.S. and the relationship to international data processing standards. This will be followed by a discussion on "Character Recognition" by B. W. Pollard, director of engineering for the Burroughs Corporation and chairman of the ASA X3.1 subcommittee on character recognition.

Other speakers on the program include Liggett discussing "Character Codes and Input/Output Media," J. C. Chu, manager of the Univac Equipment Center of Remington Rand, elaborating on "Programming Languages" as seen by the ASA X3.4 subcommittee, and Dr. A. W. Kent, deputy director of the information retrieval center, Western Reserve University, speaking on "Information Retrieval."

For registration blanks and information write to American Standards Assoc., 10 E. 40 St., N.Y. 16, N.Y.

REMRAND SPONSORS COBOL LECTURE TEAM

A COBOL lecture team from Rem-Rand, consisting of members of Dr. Grace Hopper's research programming staff at the Whitpain, Pa. Univac Engineering Center, this month completed a tour of 12 cities appraising users and field sales organizations of the company's position in COBOL development.

Translators both in planning stages and presently available for the Univac 490 Real-Time System, the 1107 and Univac II and III were discussed.

CIRCLE 100 ON READER CARD

EUROPEAN COMPUTER MANUFACTURERS ORGANIZE

The formation of the European Computer Manufacturers Assoc. was announced last month for the purpose of furthering the adoption of data processing standards through intercompany cooperation.

With headquarters and secretariat in Geneva, the first president of ECMA is C. G. Holland-Martin, research director of I.C.T., Ltd., England. Other officers include: P. Dreyfus as vice president. Dreyfus is also EDP director for the Bull Machine Co., Paris. Treasurer of ECMA is M. Pedretti, manager of systems standards for IBM World Trade Corp.

Eighteen founding members of ECMA represent computer manufacturers in Sweden, England, France, Netherlands, Belgium, Italy and Germany, including such firms as Elliott, Facit, Ferranti, ITT Europe, Leo Computers, Olivetti, S.E.A., Telefunken, and Zuse.

Four technical committees have been established to study and develop standards in the following areas: flowcharting, programming languages, character sets and code representation, and character recognition.

A stated purpose of ECMA is "cooperation with national and international standards organizations . . . through the establishment of systems and equipment compatibility, the development of common languages and in other appropriate fields of activity."

"COLOR COMPUTER" DEVELOPED BY JAPANESE

A "color computer," reportedly able to separate over 8,000,000 shades of red, and to distinguish between 100,000,000 different colors has been developed by the Tokyo Shibaura Electric Co.

Known as the Toshiba Color Computer, it combines a recording spectrophotometer and a digital computer. Able to draw a spectral curve of an object's color within two minutes, the

NEWS BRIEFS . . .

Toshiba then calculates and prints the results in 5 decimal digits on tape within 25 seconds. The computer is supposedly 100 to 1,000 times more effective than the present spectral method of differentiating color. In application, it is designed to colonize many consumer items and may be used to detect incipient diseases by analyzing skin color.

CIRCLE 101 ON READER CARD

RANDOM ACCESS DISC FILES FOR HONEYWELL 400

With a capacity range from 24-96 million alphanumeric characters, four models of random access storage equipment using magnetic discs have been announced for the Honeywell 400. Average access time is approx. 100 milliseconds and maximum access time is 170 milliseconds. Price range of the units varies from $140,000-$260,000, and rental from $2,900-$6,200 per month, depending on storage capacity. Availability is 15 months from receipt of order.

CIRCLE 102 ON READER CARD

ARMOUR RESEARCH SETS '61 COMPUTER SYMPOSIUM

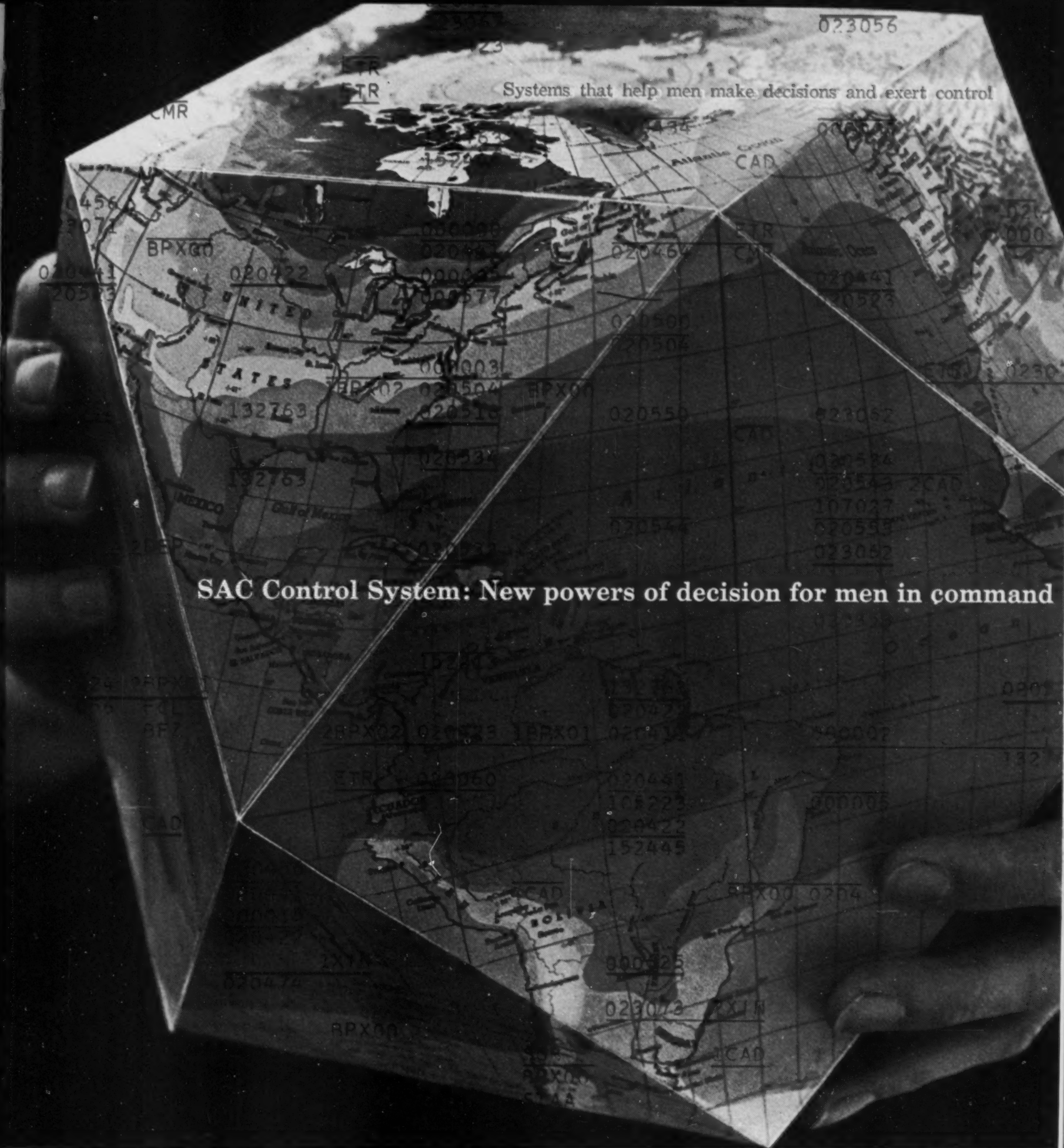
The 1961 Computer Applications Symposium, sponsored by Armour Research Foundation, will be held Oct. 25-26, at the Morrison Hotel, Chicago. User experience in computer application and programming techniques will be stressed.

Charles A. Phillips, director, Data Systems Review Division, Office of the Assistant Secretary of Defense, will be in charge of the business and management applications session on Oct. 25th, and Dr. Robert P. Rich, director, Computation Facility, Applied Physics Laboratory, Johns Hopkins University, is chairman of the scientific and engineering applications session, Oct. 26th.

Inquiries concerning the conference should be addressed to B. Mittman, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.

AMERICAN UNIV. ANNOUNCES 8TH EDP INSTITUTE

The 8th Institute on Electronics in Management, sponsored by the American University, Washington, D.C., Oct. 30 - Nov. 3, will feature topics on edp equipment, COBOL, data transmission, TABSOL, selection and training of programmers, computing in the medical sciences, management games, operations research in budget-


Systems that help men make decisions and exert control
SAC Control System: New powers of decision for men in command

ing, and organizational changes influenced by computers.

Speakers include, John Postley, Advanced Information Systems; Charles Phillips and Howard Gammon, Dept. of Defense; Samuel Alexander and James Cunningham, Bureau of Standards; Harry Harman, SDC; Harold Weiss, G.E., and W. Edwards Deming, N.Y.U.

Field trips have been scheduled for the David Taylor Model Basin, C-E-I-R, Bureau of the Census, and Army Map Service.

Information and enrollment applications may be obtained from Lowell H. Hattery, Center for Technology

NEWS BRIEFS . . .

and Administration, The American University, 1901 F. Street, N.W., Washington 6, D.C.

● George J. Vosatka has left his position as western regional manager for Bendix Computer to open a west coast office for Computer Usage Co., to be located in Los Angeles at 6266 Manchester Blvd. Vosatka's initial efforts will be in systems and applications programming.

CIRCLE 113 ON READER CARD

● The New Jersey headquarters of the Public Service Electric Gas Co. has signed a lease agreement for one RCA 601 and five 301s to handle customer billing, payroll accounting, depreciation studies, etc. Installation is scheduled for the Fall, 1962. This will be one of the first uses of the 301 as off-line, peripheral equipment for the 601.

CIRCLE 103 ON READER CARD

● Huntington Park First Savings & Loan Association has begun operation with a newly installed UNIVAC 90 system built around a UNIVAC 60, the first installation of this kind for the banking industry in the Southeast.

CIRCLE 104 ON READER CARD

● A C-E-I-R 7090 has translated an article from a Russian newspaper into English at the rate of 60,000 words an hour using a method called unified transfer system. Machine Translation Inc., Washington, D.C., are the designers of the system, which is probably one of the more complicated uses of the 90 because of the activation of all 12 magnetic tape drives.

CIRCLE 105 ON READER CARD

● A complete information storage system, delivered to Rabinow Engineering Co. by the Bryant Computer Products Div. of Ex-Cell-O Corp., marks the entry of Bryant into the memory systems field. The system, designed for the U. S. Post Office Dept., will be used for experimental coding and sorting of mail.

CIRCLE 106 ON READER CARD

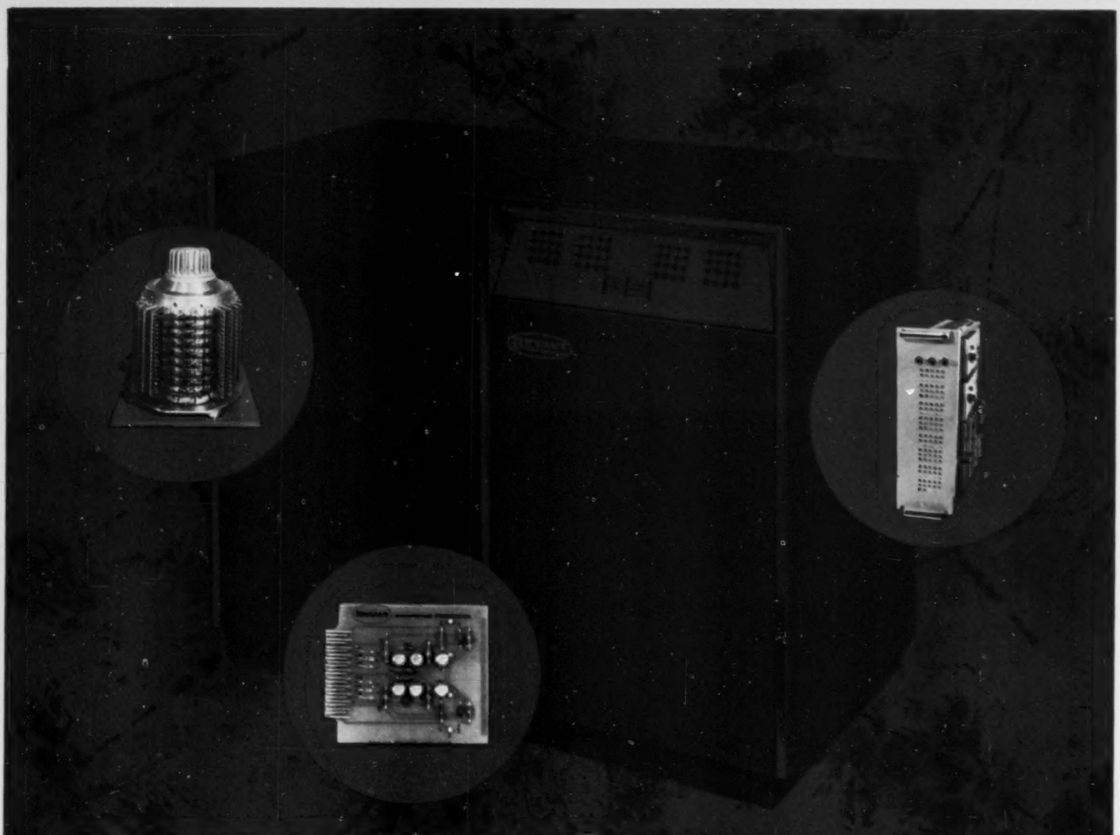
● A west coast office for Charles W. Adams Assoc. was opened last month by Milton L. Freeman, formerly in program management at Autonetics, Inc. The new office will be located at 971 South Los Angeles St., Anaheim, and will specialize in management control and management information systems.

CIRCLE 107 ON READER CARD

● Four Honeywell 209s have been purchased by Monsanto Chemical Co. for on-line process control computation at their hydrocarbon raw materials plant, now under construction and scheduled for operation late next year. The computers will continually monitor process conditions, making calculations and furnishing printed instructions to operating personnel.

CIRCLE 108 ON READER CARD

● CDC has established new offices in Washington, D.C., and will offer service to the government and commercial customers in that area. The new facilities will house 17 sales engineers, and field maintenance specialists.



BREAKTHROUGH FROM BRYANT

Now, from Bryant . . . leading supplier of magnetic memory drums and disc files . . . complete memory systems, and a full line of modular read, write, selection, and interface circuitry . . . designed and delivered by Bryant systems engineers . . . proven in commercial, government, and military service. Memory system features include:

NEW "PLUG-IN" MEMORY SYSTEMS AND CIRCUITS

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Compatible with user logic levels
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Standard rack mounting
Choice of recording modes

Design Flexibility
Frequencies to 1 MC
Serial and parallel operation
Selective alteration of data
Custom units for every requirement

Built-In Reliability
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Glass epoxy printed boards
Overload protection

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Individual circuits available include: read, write, selection, clock read, driver, inverter, flip flop, multiple gate, and power supply modules.

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CIRCLE 16 ON READER CARD

DESIGN ASSISTANCE. Get custom-designed IBM MICR checks that add to the good impression your company makes.

New paper checks with a

Your IBM supplies specialist helps put extra value into IBM MICR* paper checks

High-precision documents from special paper to the final printing, the new IBM paper checks are distinctive in appearance...and *always designed to make your company look its very best.*

But here is the most important thing...

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What's more, your supplies specialist is thoroughly familiar with check and data processing equipment. He helps you design the IBM paper check and stub which most economically meet your accounting demands and the capabilities of your equipment. He also offers free check design service and a wide selection of attractive check borders and backgrounds.

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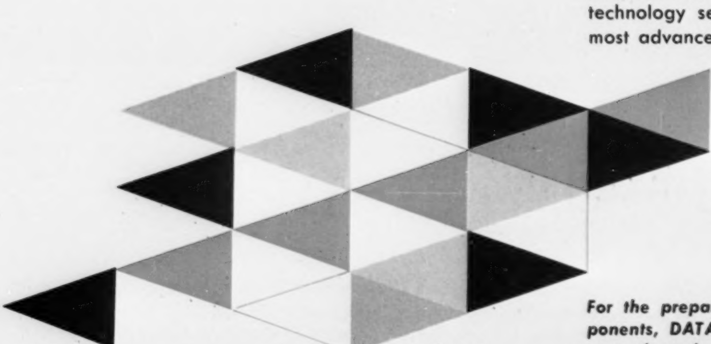
SERVICE—IBM supplies specialists provide prompt and expert technical assistance to you from more than 200 locations from coast to coast.

COMPUTER

Although there is considerable mutuality of concern in their ultimate objective: "the advancement of computer technology and application," hardware personnel and their software peers have long been widely separated by geography, education and interest, and all that is written and said has not as yet made one head out of Humpty and Dumpty.

Of course, there is some virtue in this arrangement and considerable adamance that it be kept "precisely as is." The problem however, is that the relationship of each group to the other has become increasingly complex and essential to the continuing development, and application of advanced EDP equipment. Perhaps, when the seemingly insurmountable hurdles are charged for the last time, it may suddenly appear that Humpty Dumpty is after all, a single entity and must be fitted properly together to continue sitting high on the wall.

The most pertinent querie, "What does it all mean to me?" is perhaps one clue to a more integrated working relationship, and also the most difficult to answer. For DATAMATION's first component issue, a reply has been sought in presenting a profile of tomorrow's computer technology set in the main frame of a few of today's most advanced areas of research and development. . . .



For the preparation of this staff survey on computer components, DATAMATION wishes to acknowledge the assistance through conversations and correspondence (including the submission of reference papers) of M. L. Cohen, Arthur D. Little, Inc.; Richard Crippen, Fairchild Semiconductor; Louis Delhom, Texas Instruments; Robert Schaffer and Dudley Gill, IBM; Robert L. Laurent, Magnavox Research Laboratories; R. M. MacIntyre, Aeronutronic; Ludwig Mayer, General Mills Electronics Group; W. Peil, General Electric Electronics Lab; Jack I. Raffel, Lincoln Laboratory of MIT; E. Warner White, Bell Telephone Labs, and H. H. Wieder, U.S. Naval Ordnance Laboratory, Corona, Calif., in addition of course, to the authors whose papers appear on the following pages.

a DATAMATION staff survey

COMPONENTS '61

A burgeoning range of applications for EDP equipment has had a profound influence on the development of digital computer components and in a circuitous fashion, basic and applied research in high speed circuitry, logic and memory elements, has led to the opening of new avenues in system design, application and programming.

In some instances, new components have been hopelessly outdated before they could be engineered into a system and in other cases, time alone will indicate whether a significant contribution has been made.

In areas of advanced research such as cryogenics, magnetics, microminiaturization, and others, a substantial investment has and is being made with specific concern at the computer market. Recently, there have been a number of instances where horns have been pulled sharply inward and research redirected. But both government and corporate money is still in adequate supply and where one company may have left off, another has filled the research gap.

Trends are readily apparent: high speeds, greater reliability, faster and larger memories. A prediction frequently heard is that the next generation of computers will take a huge jump in all of the above categories.

A basic need in the field, however, is far greater application of research to limitations in the design of associated equipment. "Way out" r and d efforts have remained in that category in a number of specific fields where the actual operation of a large system has not received adequate consideration. The usefulness of thin film, for example, in the small capacity word range may indeed, be begging the real question. It has been frankly pointed out that magnetics have been "almost on the verge of something" every year during the 8-9 year history of research in this field. In the micro concept, interconnection devices remain a year-round stumbling block. In tunnel diode research, lack of directionality from a system point of view has resulted in some interesting but as yet, inconclusive experimental devices.

Undeniably however, progress in computer components and ultimately, systems design, stands as one of the brighter lights focused on the horizon of the industry.

semiconductors: transistors and diodes

Transistors and diodes, separately or in combination, can be used to form logic components for the following types of logic systems: (1) Resistor transistor logic (RTL); (2) Direct-coupled transistor logic (DCTL); (3) Complementary transistor logic; (4) Current-steered logic; (5) Diode-transistor logic.

Static or dynamic logic can be used and the circuits can be synchronous or asychronous. Extensive literature exists covering these logic mechanizations which provides a broad range of logic rate-cost trade-off values. Logic rates of the order of 100 Mpps (100 million pulses per second) are realizable for relatively simple systems. For relatively low speed systems, reasonable transistors and diodes with order of magnitude costs of $1.00 and $0.20 respectively can be used.

The multitude of transistor diode types available has advantages and disadvantages. For example, an evaluation of the best transistors and diodes for the above listed types of logic mechanization on the basis of best cost-performance (performance in the broad sense) will be obsolete as soon as it is completed.

The only reasonable course is to develop standard circuit packages at reasonable intervals of time. An example of one of the more recent advances in transistor technology is the development of the epitaxial diffused transistor. The term epitaxial indicates that a film grown on a semi-conductor wafer is a direct extension of the single crystal structure of the substrate.

tunnel diodes

The tunnel diode (See Datamation, Vol. 6, No. 3, pg. 15-19) which was first reported by Esaki in 1958 is a voltage controlled negative resistance. The phenomenon responsible for the negative resistance is the quantum mechanical tunneling effect which occurs when the junction is forward biased. Tunnel diode switching times of the order of 0.1 to 1.0 nS (1 nano second = 1×10^{-9} second) are obtainable. Much literature on various circuits for use of the new device as a logic or memory component has already accumulated.

A fundamental problem with the use of this, or any other, fast switching device, is the fact that the information transfer rate cannot exceed the speed of light. Light will travel only about 1.2 inches in 0.1 nS. Consequently, as faster components, such as the tunnel diode logic circuit are used, the restrictions on the size of the system become the governing factor. This is one of the considerations which have led to the development of various microminiature components.

An important disadvantage is that the diode is a two-terminal device and therefore steps must be taken in the circuit design to provide unilateral information flow. Multiphase clocks and backward diodes on both have been used for this purpose with some success. For example, a 200 megacycle pseudo random code generator has been constructed and successfully operated.

low temperature computer components

The objects of cryogenic component research are: (1) microminiaturization; (2) high speed operation, and (3) economic fabrication of components. The first item does not imply a microminiature system. A cryogenic system

would use a Collins liquefier (Cryostat) which is not small and certainly not microminiature. However, the close spacing of the components would minimize signal propagation time although high speed operation of cryogenic components on a system basis has yet to be reported.

The first cryogenic computer device to be described in detail was the cryotron of Buck which depends upon the destruction of the super-conductive state by means of a magnetic field. A later device, announced by Crowe, operates by the principle of flux-trapping. A persistent current is set up around an aperture in a thin superconducting film. The direction of the current determines whether a 0 or 1 is stored. The Cryotron at present, because of a heating phenomenon, can only operate at about 1000 pps (pulses per second). Crowe's device, used as a persistent current memory call, has a switching speed of about 0.01 u sec. A possible memory bit packing density memory has been reported as 1 x 10^6 bits/cu ft. Cryotrons evaporated onto a suitable substrate have been suggested as a means to simplify fabrication. This creates a uniformity problem which is shared with evaporation techniques used for fabricating other types of digital computer components; for example: microminiature circuits and thin magnetic films. Electroplating and electron beam etching have also been suggested for the fabrication of cryotrons but significant results have not yet been reported.

Input/output devices for cryogenic computers are also a source of difficulty in regard to signal levels, impedence and packaging.

Another low-temperature digital computer component is the *cryosar*. The name was derived from "low-temperature (cryo-) switching by avalanche and recombination." It is a two-terminal component which operates at 4.2°K (liquid Helium at atmospheric pressure). The cryosar operation is based on impact ionization of impurities in semiconductor crystals. Two types of cryosars have been reported.

The first is fabricated from uncompensated germanium and exhibits resistivity of about 10^7 ohm-cm until a critical field of about 10 volts/cm is reached. The current then increases by as much as seven orders of magnitude.

The second type of cryosar uses compensated p-type germanium and has similar electrical characteristics except that a negative resistance region occurs between the high and low-impedance states making bistable operation possible. Thus both diode and flip-flop functions are possible. The transitions can occur in about 10^{-8} second, but are strongly dependent upon the difference between the applied voltage and the threshold voltage. If the difference is small, the turn-on time can be of the order of microseconds. Adaptation to micro circuitry has been suggested due to localization of the active region of operation to the electrode area.

magnetic digital computer components

Since the idea of using a magnetic core for digital storage was successfully reduced to practice, a multitude of magnetic memory and logic components have been devised, many of which might be considered variations of the original component. Some of the objects of these developments are to simplify fabrication, increase switching speed and decrease power requirements. Implied in fabrication simplification are decreased cost and improved component system characteristics. The latter is defined in contrast to operation of one, or relatively few components. For example, in the familiar coincident current core memories, three types of disturbances can occur which reduce the signal-to-noise ratio of the sense output. All of these are proportional to the size and speed of the memory. They are (1) magnetic pick-up caused by inductive coupling of the select lines and the sense lines, (2) electrostatic pick-up caused by capacitive coupling between the drive lines and the sense lines and (3) disturbances due to the cores because of half-select currents or leakage currents in other drive lines due to imperfect switches. Many techniques have been devised over the years since the introduction of the magnetic memory core to overcome these problems. It is only with this type of related system experience that one can consider the newer types of magnetic memory components.

However, it cannot be overemphasized that in progressing from the operation of a few components in the laboratory to the operation of many components in a large system, the uniformity and reproducibility of the components together with the complexity of peripheral equipment become improtant.

In the case of the flat thin film memories, it is very difficult to produce an array of spots having uniform magnetic characteristics. In particular the coercive force of the spots varies in magnitude and the uniaxial anisotropy or easy axis in direction from spot to spot. Ferrite core planes are assembled from toroids which are selected individually by an automatic tester whereas thin film spots are all deposited at one time and those factors which cause the changes in magnetic characteristics from spot to spot must all be eliminated in advance.

Assuming that a perfect thin film array can be obtained, some of the practical difficulties enumerated above in reference to core memories must be overcome. A typical magnetic film spot contains about one-thousandth of the flux present in a ferrite core, but the order of magnitude of the drive currents is about the same. Therefore, the sense line noise pick-up must be reduced by a factor of 1000. Fortunately it is possible to fabricate sense lines and drive lines which have very low mutual inductance. This is especially the case where an aluminum substrate has been used. A 4 x 3 inch memory of this type, containing 1250 bits, has recently been reported. The magnetic film was a continuous sheet of "Gyralloy" of 1,000 A° thickness.

Although there are many problems to be solved, it appears at this time that a satisfactory planar thin film memory will be obtained "in a reasonable time," and the ultimate advantage of simple fabrication, fast economical operation and non-destructive readout will be realized.

Efforts to reduce the cycle time to coincident core memories has required improvements in the ferrite material and reduction in the core size. A cycle time of about 2 μ sec is possible with full drive currents. For faster operation, linear selection systems, or multiple coincidence techniques in general, must be used which for large memories require proportionately more peripheral equipment, such as drivers, diode switches and timing generators. For very high speed work, diode leakage and recovery problems, transistor collector voltage breakdown, noise pick-up signal propagation time and core heating become critical. *The general tendency to produce a "more interesting memory specification" and at the same time keep the cost competitive has created a tendency for engineers to produce marginal equipment, or equipment which does not meet the original cycle time, or access time specification.*

Various multi-path cores have been developed for high speed memory applications. In general, the operation is more complex than with simple toroids both in the element itself and the circuitry required for driving. Large values of drive currents with fast rise and fall times are used which compound the sense disturb pick-up and peripheral equipment difficulties. Core heating is also a problem.

In many applications, a computer memory is read out

more than it is written in. With destructive readout memory components, each information access requires a rewrite of the information. Much time can be saved if this step can be eliminated. Furthermore, since less information is transferred, the chance of information being lost due to noise is reduced. Such memory components are termed non-destructive, (NDRO — non-destructive readout), meaning the information is not destroyed by interrogation. Those that have been introduced in the last few years include the Flux lok which is simply a 50/80 mil ferrite toroid with a solenoid winding about its outside diameter. Information can be written into the cores by the conventional coincident current technique. A current pulse in the solenoid winding effects a non-destructive readout pulse by causing a reversible flux change in the core. The flux produced by the solenoid closes in air. An output signal amplitude for a one-ampere interrogate pulse was reported to be approximately 100 millivolts, and interrogation rates of 10 Mc had no apparent core heating effects. The solenoid winding can also be used in conjunction with a write select scheme. The remarks made in this survey regarding sense line disturb voltages also apply in this case. It can be expected that nose cancelling techniques would be very important in this type of memory. Also, the interrogate lines would represent a rather high inductance for economical transistor drivers capable of supplying one-ampere current pulses with a rise time of the order of magnitude of 0.1 uS.

Another type of non-destructive memory component is the transfluxors, a two-aperture planar piece of ferrite. As used in the digital memory application, the information is stored by setting flux around the major aperture. Depending upon the amount of flux which is set, flux may or may not be switched around the minor aperture. This is termed geometrical flux transfer. Since flux must be switched for the interrogate operation, the maximum read-out rate is limited by core heating. Inductance of the drive lines is also a consideration. It should be noted here that transfluxors can perform many other functions in addition to simple digital storage. Also, they have suggested multi-aperture devices of many shapes which utilize geometrical flux transfers.

A number of schemes using a cross-field type of NDRO have been announced in the last few years. These devices utilize flux paths which close in magnetic material rather than in air as in the case of the Flux lok principle.

A magnetic computer component which does not use ferromagnetic material is the unifluxor. A unifluxor array consists of a printed-circuit board upon which are etched longitudinal drive lines and transverse sense lines. Each intersection of a drive, and sense line represents one bit, the state of which depends upon the presence or absence of a copper slug at the intersection. The copper slug causes a net flux to cut the sense line which generates an output signal. A 500 mA, 150nS drive 1 pulse is used which generates a "1" output on the sense line of about 10 mV with a reported signal-to-noise ratio greater 15:1 in respect to the "0" output. The memory contents can be etched onto a copper clad mylar sheet which is placed in register with the drive and sense lines. Consequently, the Unifluxor is particularly suited for fixed program machines. It can be considered a NDRO memory component although the type of "write-in" changes the significance slightly from that of electronic writing schemes.

Many, if not all, the magnetic digital computer memory devices described above have prospered, at one time or other, as logic components. In fact, it appears that anything that has two or more stable magnetic states is suitable for at least one paper on the subject, if not a full-scale R & D program. Examples of flux switching to obtain logic functions include the laddic, transfluxor, MAD (multi-aperture devices) and fluxor. All of these devices have one thing in common, the magnetic path lengths are relatively long, i.e. generally equal to or greater than a 30/50 toroid, and the magnetic material that must be switched is also relatively great. This leads to large drive currents or many drive turns with proportionately greater generated e.m.f. In some cases, the tolerances of the drive current magnitudes require that a considerable portion of the clock, or logic voltage be dropped across a current swamping resistor. Typically, the ratio of resistor power to core power can be between 5 to 1 to 60 to 1 depending upon the tolerances involved. A typical system might require 6 watts of clock power per element when operating at 200 Kc. A 1500 element arithmetic system would consequently require 9000 watts of clock power.

Smaller flux switching elements have been proposed to minimize the power requirement, but because of the complex shapes fabrication of the element becomes very difficult.

Some of the flux switching systems are referred to as "all magnetic," i.e., only ferrite and wire are required for the logic processing part of the system. A broader view of the term "system" should include all that is required to process the logic, i.e. overall power requirements (how large a power supply fuse should be specified) and the clock pulse specifications including power and timing tolerance. The ferrite and wire certainly dissipate energy — the energy source therefore should be included in any consideration of system reliability and applicability.

Simple magnetic toroids have been demonstrated to operate in a variety of logic mechanizations. Toroids in combination with diodes and/or transistors have been suggested. Diodeless core logic which utilizes resistors or capacitors in conjunction with multiphase clocks has been reported. In many of the hybrid core — semiconductor schemes, the purpose of the core is mainly to provide a one-clock time delay. The diodes may be used to provide logic in addition to unilateral information flow. In providing unilateral information flow, they also enable a power gain to be accomplished. Typically, these components are shown in a shifting register configuration.

To indicate the capabilities of a particular type of logic mechanization, the maximum number of inputs (fan-in) to the delay function is specified. Likewise, the number of outputs which the delay function can provide is specified (fan-out). The larger the fan-in and fan-out, the more useful is the particular type of logic mechanization. In general, most core-type logic mechanizations have fanning capabilities of less than ten which limit their usefulness to only shifting registers or serial arithmetic operations. The speed of operation is limited by power dissipation, although in general, not as much as with multi-aperture ferrite devices. For diodeless logic, the speed of operation is limited mainly by the requirement for dissipating the volt-second output from the coupling cores to achieve unidirectional information flow.

Certain core logic schemes utilize both "conventional" flip-flops and cores. The object of such systems is to reduce the number of active elements, and the implication is that system reliability is inversely proportional to the number of active elements in the system. It is certainly true that this is often the case, but a general consideration of reliability must include other factors. The point here is that a simple consideration does not guarantee reliability, the consideration must encompass all aspects of any system — *a narrow view might only trade one difficulty for another which is far more deterimental to reliable system operation.*

parametrons

The Parametron was first reported in 1954 although similar types of devices were announced much earlier. Essentially, it is a parametric phase-locked oscillator (PLO) which has the ability to perform such basic functions as amplification, logic and storage which are required in a digital computer. The PLO consists of a tank circuit having at least one reactance that can be varied by means of a "pump" voltage, current or magnetic flux which in a simple case, oscillates at a frequency twice that of the tank circuit.

The Parametron is a PLO which consists of a pair of toroidal magnetic cores (with winding), a capacitor and a resistor. In one application, the M-1 computer in Japan, the pump frequency is 2.4 Mc, and the Parametron oscillation frequency is therefore 1.2 Mc. The parametric oscillation of a PLO is stable in either of two phases, and therefore it can be used as a bistable element. If it is not self-starting, i.e., does not oscillate unless started by a signal input, even though the pumping frequency is present, it is termed a "tristable parametron." In either case, a relatively small signal input will cause the desired phase of fundamental oscillation to build up. The build up can take place in the order of 5 to 20 cycles of the pumping frequency and likewise a similar number of cycles are required for it to cease. (A factor of 120 is used in the M-1). To provide unidirectional information flow the Parametrons are arranged in three groups with each group excited by a separate pump (or excitation) source. This corresponds generally to the three-phase clock used in tunnel diode logic systems. Although the frequency of operation of the Parametron is relatively low due to the ferrite losses, as compared to other types of logic mechanizations, it is capable of being used in a parallel arithmetic unit which considerably improves its utility. Also, majority logic can be mechanized.

Magnetic core memories using the Parametron principle for read, write and selection are in use which indicates that the principle is generally very useful for digital computer mechanizations. The reasonable simplicity of the Parametron component and the reduction of the required active components to mechanize a logic system has been cited as contributing significantly to the art of producing low cost, high reliability computers. In 1959 it was reported that half of the Japanese electronic computers in operation use parametrons for logical elements.

In an effort to obtain a very high frequency PLO, semiconductor diodes have been investigated in conjunction with microwave techniques to obtain information rates in the 1000 Mps range. It is evident that there will be a fundamental limitation in the size of such a computer because of free space propagation rates as mentioned in the comments on tunnel diode logic. This again indicates the need for small components if a very high speed, complex data processing device is to be built. However, present techniques, e.g., the strip transmission lines, might also be useful where relatively simple logic mechanizations are required.

the micro concept

Because of the increasing performance requirements for digital data handling devices for aero/space vehicles, the trend toward reduction in size, weight and power consumption and increase in reliability of digital components has been very evident in the last few years. Although the general requirement of portability could be said to contribute to this trend, it was the proximity fuze of WW II that really provided the initial impetus. The micro concept covers a spectrum from micro components which are recognizable scaled down versions of conventional components to devices which will perform the function of a conventional component but are not constructed of recognizable, lumped R, L and C elements. In the former category are components, e.g., flip-flops and gates composed of miniaturized transistors, diodes and resistors. These elements are available as separate units, such as micro diodes and transistors which achieve their small size by means of surface passivation instead of being encased in a hermetically sealed can.

Resistors and capacitors are formed on substrates by various deposition processes. In some cases the diodes and transistors, such as the Germanium diffused type, are formed directly on the substrate by photolithographic techniques. Commercial germanium alloy junction transistors are removed from their cases and placed in recesses in the substrate. This type of microminiaturization of electronics is termed microelectronics. For thin wafer, high parts density substrates, the technique is termed DOFL-D or simply 2D, (DOFL stands for Diamond Ordnance Fuze Laboratories, where much of this work has been accomplished).

If the substrate used is a semiconductor crystal, both active and passive circuit elements can be formed on it, including at least some of the interconnections. The transistors and diodes are formed by bulk resistance and capacitance from the depletion-layer of a biased junction. Using this technique, a full serial adder has been constructed with 13 solid state circuit networks — total weight, 1.5 gm, volume, 0.02 cu. in. Although the number of elements and connections is considerably reduced, interconnections between networks is a problem. Another problem is heat dissipation, since mesa transistors do not operate well at low values of collector microcircuits, electron beam fabrication techniques are being studied. The goal is to form complete circuits within a vacuum system.

Another approach to microminiaturization is molecular electronics in which the concept of a conventional circuit is discarded. Instead, building blocks having "subsystem capability" are produced. For example, multiple position switches (Dynistor and Trinistor), bistable, monostable, astable multivibrators, and an analog-to-digital converter employing an NPNP relaxation oscillator have been reported. In these devices, there are no internal connections or components and the only external connections are those needed for coupling with the complete system. A modification of the dendrite process of crystal growing (the crystal is ribbon shaped) which makes it practical to carry out diffusion, alloying and evaporation processes directly on the crystal as it grows from the furnace melt, has contributed greatly to the advancement in this area.

for the R&D engineer

To determine what component or components are best is perhaps the most difficult question the computer industry must face today. Screening the vast body of literature available is a tedious process and to a large extent, lacking in scientific approach and inhibited by the NIH factor (Not Invented Here). The latter is also confused with the economics of avoiding patent complications, as well as the usual problems of overstatement, understatement and lack of adequate reference.

In a fashion once again, vaguely reminiscent of a closed loop, the application of mechanized information retrieval may very well produce a reliable answer to this problem — from the engineer's design of an efficient large memory system for IR, to the programmer's implementation and back again as useful readout to serve the engineer.

DESIGN OF A LARGE SCALE CRYOGENIC MEMORY

by D. R. YOUNG, Data Systems Division, Development Laboratory, IBM

Superconducting devices offer potential advantages for use in computers in the area of ultra high speeds and in the area of moderate speed — large scale systems. This paper is the result of a study to ascertain the feasibility of using superconducting devices in the latter area to replace magnetic cores for a large memory system. This takes advantage of the possibilities of using mass fabrication techniques and, in addition, the possibility of simultaneous construction of passive and active devices.

It was decided to use sense amplifier output rather than cryotron output since the latter would require at least 2 cryotrons/cell and, in addition, the output cryotron would have to be large enough to drive an entire memory line rather than just a small loop.

As a result, the size of the memory would be reduced by a factor of 3 or 4 and the cost of sense amplifiers is not sufficient to warrant this loss in memory capacity. Difficulties encountered when cryotrons are used to switch between substrates led to the placement of decoders on each plane and then to use external transistor drivers to select the planes. It has been shown that the input-output requirements can be met without excessive dissipation in the liquid helium.

The memory size proposed is around 5 megabits and means for doing this using "3D" and "2D" configurations are described.

memory cells:

Two types of memory cells have been considered; the Crowe-RCA scheme and the single cryotron loop.

The Crowe-RCA scheme is shown in figure 1. Early work on this cell was reported by J. Crowe[1] and more recently by Parkinson[2] and Burns[3]. In addition Burns (loc. cit.) has suggested the substitution of a continuous film for the double dee configuration. This simplifies the construction and, in addition, improves the reproducibility, according to Burns. The advantages of this cell are compactness; simple construction; can be used for "2D" or "3D" configurations; requires relatively small driving current; and output is well shielded from input.

Its disadvantages are that it requires imperfections in the film which may be difficult to control; has relatively narrow tolerances, and requires bipolar inputs.

It remains to be seen if sufficient reproducability can be obtained on a large scale to make this cell useable.

The single cryotron loop is shown in figure 2. This cell can be made relatively compact by returning the loop over the top of the gate. The advantages of this cell are that it is reasonably compact; has very broad tolerances, and requires monopolar inputs.

Its disadvantages are that it can be used for "2D" only, and requires moderately large driving currents.

decoder:

For this application the "Christmas Tree" type of decoder is recommended because of its simple construction and its broad tolerance limits, even though it is not the most efficient circuit. The switching elements recommended are "In line Cryotrons" whose length is adjusted to drive the memory lines at the required speed. Adjustment must be made for the fact that the effective output impedance is equal to the impedance/cryotron divided by the number of levels or 8 in this case. It turns out that this can be done and still permit the construction of the decoder in a reasonable space.

specifications for "3D" memory:

The "3D" configuration for an 8 x 8 plane using the continuous sheet memory is shown in figure 3. The X_1, X_2 . . . X_n and Y_1, Y_2 . . . Y_n lines come from external drivers and likewise the Z select line comes from an external driver. There are four output sense lines per plane that are not shown. The specifications that result are:

1. Memory cell size .020" x .020".
2. Substrate size 6.5" x 6.5".
3. Insulation thickness 10,000 A.
4. Tin gate film thickness 10,000 A.
5. Inductance of memory line 1.05 x 10^{-9} H (connected to decoder).
6. Resistance of in line cryotron 4.2 x 10^{-2} ohms or .22" long.
7. First four stages of decoder constructed with in line cryotrons perpendicular to memory lines.
8. L/R time constant for driving memory lines 2 x 10^{-7} sec.
9. Sense line propagation time .11 usec.

This paper is based on a presentation at the Symposium on Large Capacity Memory Techniques, May, 1961, sponsored by the Office of Naval Research, in Washington, D.C.

10. Memory cell time constant 2×10^{-8} sec.
11. Transmission delay for controlling decoder .035 usec.
12. 70 4-channel sense amplifiers.
13. 32 switching lines for decoder.
14. 280 output signal lines.
15. Total memory size 4.29×10^{6} bits made of 70 planes of 256 x 256 each.
16. Total power dissipation in helium is 2 to 3 watts.

specifications for "2D" memory:

The "2D" configuration is shown in figure 4. The Y select lines, the X select lines and the current supply lines come from external drivers. The sense output is taken from the Y select lines. The specifications that result are:

1. Memory cell size .030" x .020".
2. Substrate size 9" x 9".
3. Insulation thickness 10,000 A.

CROWE - RCA CELL

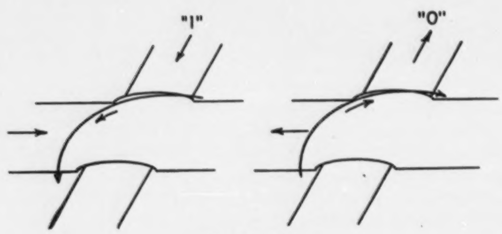


Figure 1

4. Tin gate film thickness 10,000 A.
5. Inductance of memory lines 1.67×10^{-9} H (connected to decoder).
6. Resistance of in line cryotron .030 ohms.
7. First four stages of decoder constructed with in line cryotrons perpendicular to memory line.
8. L/R time constant for driving memory lines = .45 usec.
9. Sense line propagation time .066 usec.
10. Memory cell time constant 2×10^{-8} sec.
11. Transmission delay for controlling decoder .134 usec.
12. 144 2-channel sense amplifiers.
13. 32 switching lines for decoder.
14. 144 signal output lines.
15. Total memory size 3.69×10^{6} bits made of 100 planes of 288 x 256 bits each.
16. Memory folded once on each plane – 144 bit/words.
17. Total power dissipation is 3-4 watts.

input-output:

There are three important considerations concerning the transmission lines to carry the information into and out of the helium bath.

1. Thermal conduction into helium bath.
2. I^2R heating with resultant energy losses in helium.
3. High frequency behavior.

In addition, there are three separate needs for transmission lines that need to be considered.

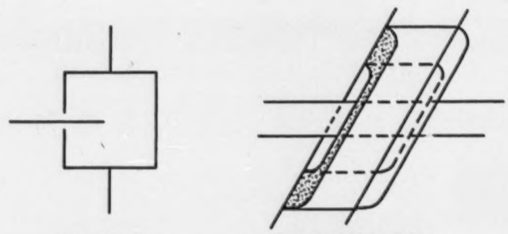
1. Signal output lines.
2. Current supply lines for each plane (Z select).
3. Memory address lines driving decoders (X, Y select).

signal output lines:

Since there is negligible I^2R heating in these lines, only considerations 1 and 3 apply. Very small coaxial cable has been constructed using stainless steel tubing (in one case .010" I.D. and .018" O.D.) and insulated #40 wire for the center conductor.

Measurements have shown that pulse rise times of 6-8 musec can be obtained using 3 feet of this line even at room temperature. With a portion of the line at helium temperatures, the pulse response should be somewhat better since the resistivity of the copper decreases by a factor of 100. This pulse response is certainly adequate.

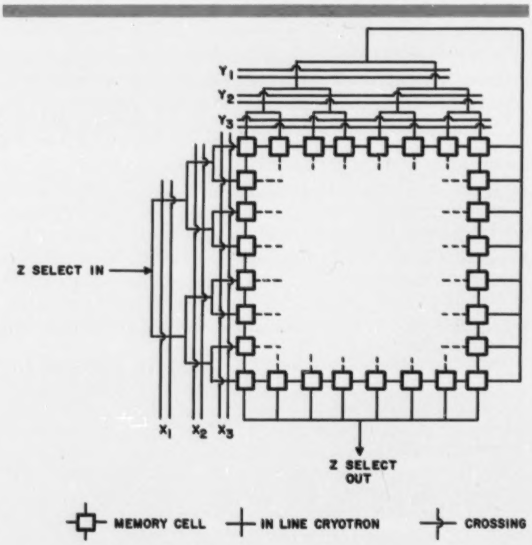
The thermal losses of the coax can be estimated using 30 W/cm°K as the thermal conductivity of copper[4] and 1.5×10^{-2} W/cm°K for stainless. This yields for 1 ft. between 70°K and 3.5°K, 2.98×10^{-3} watts for copper and 3.64×10^{-5} watts for stainless so that heat conducted by the stainless is negligible. For a total dissipation due to this source equal to 2 watts we can have 335 leads which seems adequate for four channels/plane. At room temperature the resistance of the stainless steel is 2.2 ohms/ft.



CIRCUIT CONSTRUCTION

CRYOTRON MEMORY CELL

Figure 2



256 x 256 PER PLANE
70 PLANES

Figure 3

and decreases to 1.8 ohms/ft. at nitrogen temperatures. The resistance of the copper wire is 1.05 ohms/ft at room temperature and decreases to .01 ohms/ft. at helium temperatures. The characteristic impedance of the line is about 50 ohms.

For the current supply lines for each plane there is an I^2R loss in the conductors as well as thermal conduction

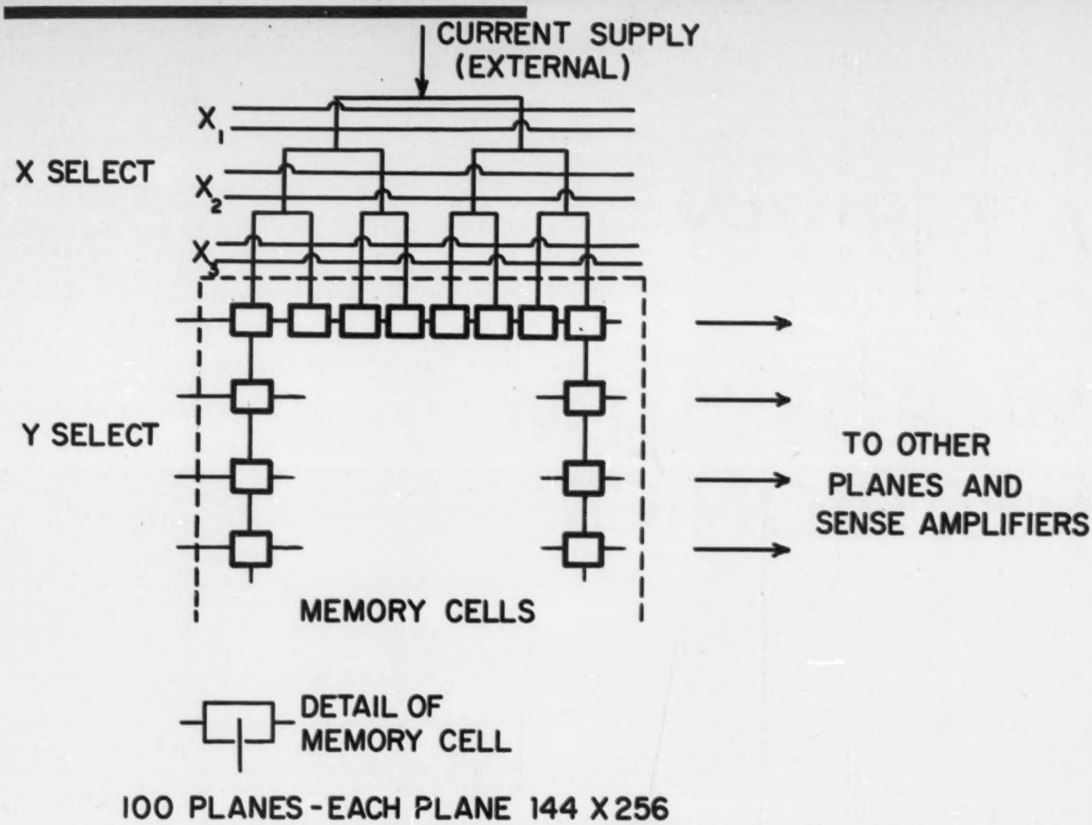


Figure 4

loss. As the cross-sectional area increases, the thermal losses increase whereas the I^2R losses decrease, resulting in optimum cross-sectional area.

This problem has been considered by McFee(5) who concludes that the heat flow for one end at 74°K and the other end at 3.5°K is .009 watts/amp. under optimum conditions. This varies as the first power of the current rather than the second power, since the optimum cross-sectional area decreases as the current is decreased. For a current of 500 m.a. then the dissipation would be .0045 watts for a duty cycle of 50% and two conductors. For 70 memory planes, the dissipation due to this cause would be $4.5 \times 10^{-3} \times 7 \times 10^{1} = .315$ watts, which is certainly reasonable. The optimum cross-section is given by

$$A = \frac{LI}{10^5} \text{cm}^2$$

or for a line 1′ long and a current of .5 amp. with a duty cycle of 50%

$$A = 7.6 \times 10^{-5} \text{ cm}^2$$

If the line is .02″ wide, then the copper thickness would be 1.5×10^{-3} cm or 5.9×10^{-4} inches. This seems reasonable and can be done with electroplated strip transmission lines. Using teflon insulation .0005″ thick the characteristic impedance would be 6.65 ohms.

memory address lines for driving decoders:
The same considerations apply as above with the exception that these lines are much longer. For example, if only a single pair were to be used for the last level of the decoder, then the length of these lines would be equal to the width of a substrate times the number of substrates or 35 feet. To decrease the time associated with this, the number of these lines can be doubled. In any case, the lines are too long to permit ringing and therefore an approximate impedance match must be obtained This characteristic impedance is around 1 ohm, so the input-output lines should be designed for 1 ohm and extra lines used to come out of the helium bath to an external termination. Strip lines with this characteristic impedance would be .133″ wide, assuming teflon insulation 5×10^{-4} inches thick is used. This is reasonable considering the fact that there are not too many of these lines needed.

The energy dissipated in terminating these lines could be ¼ watt per line which would be excessive if done in the liquid helium. These lines should be returned outside the helium bath and terminated at room temperature. Since the impedance is of the order of 1 ohm, it should not present a difficult problem for the transistor drivers since the back voltage would be only about ½ volt.

NOTES

1. J. W. Crowe, IBM Jour. of Res. and Dev. 1, 294 (1957).
2. D. H. Parkinson, Solid State Electronics 1, 306 (1960).
3. L. L. Burns et al, Solid State Electronics 1, 343 (1960).
4. This is an average value between 4°K and 70°K taken from Bureau of Standards Circular 556, page 20.
5. Richard McFee, Rev. of Sci. Inst. 30, 98 (1959).
6. This assumes that the connections between substrates will increase the impedance from .5 ohm to 1 ohm.

A SURVEY OF MICROSYSTEM ELECTRONICS

by PETER B. MEYERS, Staff Scientist, Applications Engineering, Motorola Semiconductor Products

From the Sunday supplement monster, the computer has become within 15 years, an accepted tool in engineering, banking, payroll, data reduction, numerical analysis, process control, etc. From ENIAC to a total of nearly 5000 installations, this "bigness" of the computer industry has in many ways been built on "smallness" of the individual computers themselves. Early hardware permitted sophistication only at the cost of greatly increased size, and a vacuum tube computer with the complexity of a human brain might well require a Pentagon to house it, and a Niagara for power and cooling. SAGE, effective as it is, represents about the last of these pioneering first-generation computer systems.

Semiconductor devices were being introduced at the time the first computers were built, and of course, played no part in their design or manufacture. But the many obvious advantages of transistors and diodes hastened the second generation of computers. Among the reasons for this almost complete switch to solid state are reduced size and power requirements, increased reliability, and new logic approaches. The semiconductor device requires only a fraction of the volume, power, and cooling its vacuum tube predecessor needed. It is inherently more reliable and this is a two-fold blessing since redundant circuits can be eliminated in many cases. Parallel mode operation has become practical, as have complementary circuits and other configurations not possible using tubes.

Today about one-fifth of all computers are solid state designs. Sophisticated systems have been miniaturized, subminiaturized, and compressed into ever smaller volume as packaging density increases. Tiny, missile-borne computers with sizable memories and high operational speeds already exist. But this achievement has itself triggered another round of sophistication, with demands for even faster information retrieval, translation, and processing. Associative memory and machine learning presuppose a multiplicity of interconnections practical only by further shrinking of component size. As the state of the art begins to draw inferences from the complexity of the human computer with its multibillion neuron network, the only avenue that seems feasible is that of circuits resembling to some extent the control and signaling processes of living organisms. *The ultimate in computer circuitry may well be bionic in nature.*

Since it seems that continued growth in the computer field is predicated on the further shrinking of components, it is instructive to study the background of microsystem electronics in general, with particular attention to that branch the industry has begun to call "integrated circuitry."

definition

We define an integrated circuit as a combination of a number of basic electrical elements on or within a single chunk of material, to perform a circuit function.

The concept and terms used can be illustrated by a simple four-box picture. Let us arbitrarily divide electronic technology into the following mutually exclusive and exhaustive categories: materials, components, circuits, and systems. If we investigate the emissive properties of a heated tungsten wire or the dielectric constant of polyethylene we are clearly studying the properties of *materials*. If we combine a tungsten wire, some bits of nickel wire and sheet, put it all in a glass envelope which we then evacuate, we have made a vacuum tube — a *component*. If we properly connect our vacuum tube, an inductor, a capacitor and a battery, we have an oscillator — a *circuit*. Finally, if we combine an oscillator, a modulator, an amplifier, a power supply, and an antenna, we have a transmitter — a *system*.

Integrated circuitry removes the internal partitions and integrates the four boxes into a single field. Integrated circuitry still has its specialists, but each must have a working knowledge of the problems and objectives of areas which yesterday were the exclusive domain of other specialists. As an example, a conventional circuit designer builds a power supply with a transformer, a diode, a choke, and a couple of capacitors or a simple RC filter. He has used a minimum of five components. An integrated circuit designer might choose to build the same power

supply from a single piece of silicon. Alternating current flowing through one part of the silicon encounters resistance and generates heat which filters through the silicon to a thermoelectric area, where Seebeck effect produces filtered direct current. This particular example happens to be one in which the integrated circuit bears little resemblance to its conventional counterpart. The basic electrical elements used include resistance for the generation of heat, transistance in the conversion by Seebeck effect of heat to direct current, and thermal and electrical insulation at appropriate places.

Advanced as it is, integrated circuitry is nevertheless made up of the same six basic electrical elements which long have been the basis of the electronics art plus some special combinations. These elements are insulation, conduction, resistance, capacitance, inductance, and transistance. The first five have their customary meanings. Transistance is a new and highly useful term which describes the gain of active elements, or their ability to achieve precise control. It applies to all conventional forms of transistors, diodes, and other solid state active elements. Finally, by special combinations we mean elements that can only be approximated by networks in our conventional technology. The prime example is the distributed resistance-capacitance network as realized in integrated circuitry by a thin-film resistance deposited upon a dielectric layer, which itself has been deposited on a conducting medium.

evolution of microsystem electronics

The trend was set by *miniaturization* which made use of smaller forms of conventional components interconnected by conventional wires and solder. In every case the discrete nature of the individual component and usually its conventional form has been maintained. Miniaturization represents the first step, chronologically, in the attempt to make electronic equipment smaller.

The next step was *subminiaturization* with still smaller forms of conventional components. In most cases the conventional form of the component has been maintained but the size and weight are reduced to the point at which thin wire leads provide adequate support for mounting. The cordwood technique, in which cylindrical axial-lead components are stacked with their leads fed through matched holes in parallel printed circuit boards in front of and behind the stack, is a good example. Various forms of printed or etched circuitry, both rigid and flexible, are used as the combination wiring harness and support.

Microminiaturization is the ultimate size reduction of the individual component. It differs from subminiaturization in that the conventional shape and form factor are generally lost, leads are often left off, and a supporting board or matrix is always necessary. Microminiaturization still permits the circuit designer uninhibited freedom of choice in the selection of individual components. Pill components pressed into recesses in printed circuit boards are examples.

Thin-film integrated circuitry represented a major advance by dispensing with separate mechanical supports for each component and combining multiple thin-film components on a single glass or ceramic substrate. Overlapping or touching films form internal connections. At present a hybrid form of thin-film integrated circuitry is necessary since none of the many companies working in this field has perfected a way to fabricate workable thin-film diodes and transistors on a glass or ceramic substrate. Current thin-film integrated circuit technology involved deposition of thin-film passive elements followed by the applique of any required active semiconductor elements.

Semiconductor integrated circuitry is the combination of thin-film and semiconductor circuit elements on and within a single-crystal semiconductor substrate. Connections are made by deposited thin-film conductors, and by physical juxtaposition. Of all the existing forms of integrated circuitry, the semiconductor version permits the widest variety of active and passive elements and the greatest potential flexibility. Active elements can be formed within or on the substrate where needed, and either thin-film or semiconductor techniques can be used to form the passive circuit elements. When semiconductor technologists have perfected a means of depositing thin-film semiconductor active elements on glass or ceramic substrates, the passive substrate approach may well prove more flexible than the active substrate approach. This comes about because part of each active element is unalterably connected to a common semiconductor crystal in the active case. Although careful placement of active elements and tailoring of the shape and thickness of the active substrate between may allow quite complicated circuits to be built into a single semiconductor substrate, more complex circuits could undoubtedly be achieved if both active and passive elements could be deposited on an insulating substrate.

Morphological integrated circuitry – the functional block – is the combination of solid state materials to perform a desired circuit function, although neither individual components nor precise electrical circuits are necessarily identifiable. The power supply mentioned earlier is a morphological integrated circuit. Another example is the familiar standard frequency quartz crystal, which is a homogeneous slab of material although it acts as a combination of resistance, capacitance, and inductance. The lack of a physical counterpart in conventional circuitry makes this type of integrated circuit the most difficult to design. However, there are many unexplored physical effects awaiting our attention, and the possibilities are unlimited.

integrated circuitry philosophy

Having briefly examined what it is and the evolutionary stages through which it is developing, let us consider some of the motivations for the development of integrated circuitry. Although there may be disagreement as to order of importance, it is not hard to identify the following areas of concern as having motivated the electronics industry in this field: reliability, size and weight, speed, power consumption, accessibility and cost.

reliability

Everyone talks about reliability, and it is certainly true that without a definite minimum of reliability neither microsystem nor any other kind of electronics can long endure. There is significant cause to expect better reliability from integrated circuitry than from conventional component electronic circuitry for at least two reasons: first, because the number of discrete point connections is greatly reduced and connections have always been one of the sources of failure; and second, because the overall reliability of the system is no longer the same complicated function of the individual reliabilities of each individual component. This latter claim stems from the common mode of fabrication of integrated circuits where all elements of a given type, say capacitive, are usually created at the same time. This common fabrication may seem to have more bearing on process yield, and hence cost, than on reliability but there is a greater reliability implied in the reduction of total process steps and the consequent greater attention that must be paid to each process step.

It is true that electronic systems grow progressively more complex. *With increased numbers of components all having to function together, we seem to be approaching an asymptotic barrier where additional complexity can be achieved only at the cost of decreased reliability.* While

we are still a long way from the machine with infinite complexity and zero reliability, our modern systems are already uncomfortably close to the complexity-reliability barrier.

size and weight

At least four considerations can be grouped under the heading of size and weight. For missile and other airborne applications the size and, often more important, the weight of an electronic system have a cost in propulsion machinery that provides a strong motivation for reducing them both. While reliability is of very great importance in some of these applications, reducing size and weight to particular values can mean the difference between the possible and the impossible.

A second size and weight motivation is found in the realm of portable products where the size of a potential market, both industrial and military, often depends on whether a system can be created and packaged within certain limits.

A third motivation for size reduction is economic, where equipment must be housed or protected or otherwise maintained in certain conditions. If the cost of providing a required environment is high enough and is proportional to the volume required, considerable effort can be justified in reducing the volume. A final motivation is shared with the next area of concern.

speed

For a long time, increasing the speed of electronic systems was a matter of improving the components. Recently the speed of certain systems has reached a point where propagation delays in the wiring, rather than the characteristics of the devices, prohibit faster operation. This point — often called the speed-size ceiling — has important bearing on computer systems. If a particular system has reached its speed-size ceiling, it is impossible to expand it functionally without decreasing its speed of operation, and vice-versa. The only way through a given speed-size ceiling is to decrease the physical size of the system and thus shorten the propagation delay through it. Microsystem electronics, and particularly integrated circuitry, shows promise of substantial improvement in speed-complexity product by significant reduction of propagation delay within and between integrated circuits.

power consumption

Information, in an electronic system, must be related to some form of energy if it is to be processed. In general, the amount of energy contained in a given piece of information is very small in comparison to the energy expended in processing it. In part, this is because of the inefficiency of the processing equipment, but often a much larger drain is deliberately introduced to assure continued operation in the event of drift or change in certain component characteristics. Where many different processes are involved in fabricating the components for equipment, many different and often uncorrelated drifts and changes may be expected. To assure proper operation under these conditions may require ten or even one hundred times the power needed in the absence of change. The advantage of integrated circuitry in this respect is based on the reduction in number of the different processes involved in fabricating the equipment. For example, if all resistors have the same temperature coefficient and aging characteristic, variations in bias and operating point of associated active elements will be much reduced.

Of course, not all resistors useful to integrated circuitry are made by the same process. However, many of the resistors in a given integrated circuit will not only be made by the same process but will also have been made at the same time from the same material and under a single set of conditions.

accessibility

First, it is apparent that those parts of electronics systems that must interact with a human operator must be matched to him in physical size. Knobs must be such that fingers can grasp them, dials of a size that the eye can read them, and so forth. Input and output equipment must be matched to the environment from which it receives and to which it gives information. These are problems of accessibility where limits of useful size reduction can be determined and beyond which it is neither reasonable nor desirable to go.

A second set of problems arises from the need for replacing defective parts of the system. It is no longer feasible to think of repairing a failure. When some part of an integrated circuit stops working, it cannot be operated upon in the field. *The service man must treat the entire circuit, perhaps even a group of related integrated circuits, as a single "component" which he replaces by a new "component" from an inventory of known working spares.* But we cannot afford to throw the radio away just because the dial is broken, and hence we have the problems of suitable modular subdivision and of accessibility for replacement. The problem further breaks down into those of size and of interconnections.

The problem of size in accessibility for replacement is much like the first problem of matching to a human operator. The technician must be able to get a grip on the faulty module to remove it.

The problem of interconnection is much deeper and more fundamental. It reaches across and can nullify the motivations of reliability, size and weight, and speed as well as accessibility. Many existing electronic systems use almost as much volume for interconnecting wiring behind the panel as they use for components out in front. Unless the connecting means from circuit modules to wiring harness is more reliable than the integrated circuitry itself, system reliability will be hurt. If the wiring harness is physically long, the propagation delay from one part of the system to another reduces the maximum speed of operation. Finally, unless the interconnecting means is flexible and cleverly arranged, it may be almost impossible to get at the connections to replace a module, since the motivations of reliability and size tend to rule out the use of plugs and sockets.

The final problem is the removal of heat. The potential saving in power through an allowable decrease in operating margins has already been mentioned, but even so a significant part of integrated circuit design is thermal in nature.

cost

Initially, some of the specialized applications for which there are no other possibilities will probably support integrated circuitry regardless of cost. Any sort of general acceptance, however, will require a cost competitive with other forms of circuitry. Since individual components can no longer be selected after manufacture, both control of process and process yield will have to be high. An aid in this respect is the fact that the same process run usually forms all of a given type of circuit element on a particular integrated circuit substrate and thus, if one part is good, all tend to be good. This simultaneous fabrication of all diffused resistance regions or all deposited capacitors at the same time is one of the advantages by which its proponents hope to lower the cost of integrated circuitry.

designability

The development of integrated circuitry depends not only

on being able to fabricate and interconnect the basic circuit parameters discussed above but also on knowing which techniques are compatible, what range of parameter values is realizable, what reliability individual circuit functions may be expected to have and what control is possible in the constituent processes. It depends on the design of processes that fit into automated manufacturing methods. It depends on building into the manufacturing methods, from initial concept, sufficient flexibility that the output of the product line can be changed quickly and easily to yield a different integrated circuit.

Finally, the widespread development of integrated circuitry depends on being able to accomplish all the necessary functions and operations economically. In the last analysis, it is cost that will determine the acceptance and use of integrated circuitry. If a particular fabrication process cannot be made economically competitive, it is the wrong process.

future speculation

Microsystem electronics has struggled through a variety of stages on the way to maturity. Undoubtedly it has a long way yet to go. But the need, significance, and accomplishments to date are such that it can no longer be ignored by the computer industry. For a while it will be used mainly by those for whom nothing else will do, primarily because of size and weight. After reliability is proved there will probably be another period when the main use will be in military applications. Developments during this period will determine whether integrated circuitry spreads throughout our electronics industry or remains with a few specialized applications. *The determining factor will be cost*. When the ultimate cost can be brought down to that of conventional computer circuitry, integrated circuitry will spread into large segments of the electronic computer industry.

Such an acceptance of integrated circuitry will in turn force another integration. During the proving period computer manufacturers will probably be willing to design their equipment around available integrated circuits, but the time will come when the computer design engineer will demand greater freedom of choice in selecting the particular integrated circuits from which he builds his machine. When this happens, our industry will go through some interesting gyrations; computer equipment companies will be pushed into the semiconductor and solid state materials and components business, and the semiconductor products manufacturer will be forced into the systems engineering and equipment fabrication business. The end point will be remarkably similar for the two, even though there will always be differences in accent and degree. When dynamic equilibrium is reached, not only the electronic circuitry but the people who create and use the new circuitry will be integrated to an extent unknown today.

There will always be specialists, as there always have been, but the new specialists will have a broader base which will frequently extend into more than a single scientific or technological discipline. The new specialist will understand and speak the languages of the associated disciplines and will contribute his point of view in matters that previously were considered the exclusive concern of others.

The successful integration of computer circuitry will depend upon demonstrating adequate control of designable, compatible, and above all reliable techniques.

from American Systems

THIN-FILM SHIFT REGISTER

An operational prototype of a magnetic thin-film shift register offering extremely small size, large memory capacity, and high operating frequency was announced last month by the Research Laboratories of American Systems Inc., Hawthorne, Calif.

Approximately 1" x 3" in size, the shift registers have memory capacities ranging from 128 to 256 bits, and will operate up to 1 megacycle per second in frequency. These characteristics are achieved by a unique register design, and by proprietary vacuum deposition processes in which several thin-film alloys are deposited with extreme precision on the small-size substrate.

A variety of applications are visualized for the thin-film shift register. In a typical application such as buffering, the production version of the register will be completely interchangeable with units performing this function in existing systems. The cost per bit of information is expected to be appreciably lower for most uses.

New computer designs may, of course, take advantage of the new register's size, completely solid state construction, capability for reverse information flow in the device, and freedom from radiation sensitivity of the ferromagnetic film.

It was stated by ASI president R. J. Shank that limited delivery of the thin-film shift registers is scheduled for January, 1962.

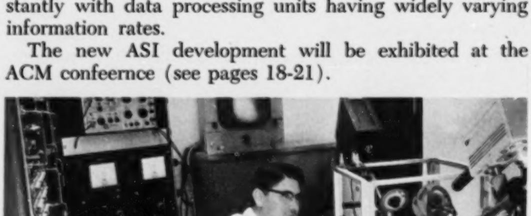
The advanced design and the fabrication processes are based on the register invented by K. D. Broadbent, well known innovator in the magnetic thin-film field. Broadbent described his early shift register in September, 1960, in an IRE professional group paper. The new register design greatly improves bit definition, increases immunity to noise, and raises top operating speeds.

Planned as a microminiature, integrated operational package, the register units will include all necessary driving and readout electronics. A novel readout method, based on the magneto-resistive effect, will be used to maintain high signal-to-noise ratio from the miniature units.

A number of other advantages are cited for the ASI development. In the thin-film shift register, digital information is translated from place to place through the magnetic surface without the necessity of moving the surface physically, as is done with magnetic drums and tapes. It is also unnecessary to convert magnetic information into electrical signals, as in the magnetic toroid shift register.

Fundamentally, this permits higher efficiency in terms of storage density, required power, and over-all weight and volume. And because the thin-film registers do not involve inertial elements, they can be synchronized instantly with data processing units having widely varying information rates.

The new ASI development will be exhibited at the ACM confeernce (see pages 18-21).



ASI thin-film shift register mounted in closed-circuit TV, making visible the pattern of magnetic domains.

The use of a semiconductor material to perform a complete circuit function promises several significant advantages to users and equipment manufacturers for computer applications. The present state-of-the-product development, however, does not allow conclusive data to prove these advantages.

The immediate and tangible advantage is extreme size and weight reduction. There are limited applications for military equipments that demand this characteristic. As the circuit function's pulse speed achieves the 20 to 100 mc range, the extreme small size may be an important factor in reducing transmission time between the chasses of a large computer.

The potential advantages are improved reliability and lower cost. These will probably be more evidenced in the coming years for digital circuits than analog circuits. A continuum of high-purity semiconductor material offers a degree of process control that is not attainable in an assembly of conventional components. The low cost is based upon the experience of producing transistors and diodes that employ similar fabrication techniques. Further, the uniform package form factor may aid the automation of equipment assembly further reducing the overall equipment cost.

INTERCONNECTION TECHNIQUES FOR SEMICONDUCTOR NETWORKS

by J. S. KILBY, Texas Instruments, Inc.

The semiconductor miniaturization approaches which have been described recently have promised complete electronic equipments of extremely small size, light in weight, and of high reliability. Although complete equipments have not yet been built from these devices, this paper will describe some of the factors which must be considered in equipment design and show one technique which might be used for high density equipment.

A typical unprotected semiconductor network is shown in Figure 1. This device is a flip-flop with sufficient gating to permit its use as a counter, shift register or set-reset flip-flop. In this design, two transistors are formed on square mesas near the center of the silicon bar. The material between the transistors forms the collector load resistors. The upper pair of arms extending from the center area are the cross coupling resistors, while mesa areas on these resistors provide the speed-up capacitors. The lower pair of arms is used as resistors on the gating networks. The four diodes required for gating are located along the lower edge of the bar. Two capacitors are formed on a separate bar, using the silicon oxide technique. Thermo compression bonded leads are used to make connections between areas on the upper surface of the bar and for some of the external connections.

In order to be useful, this device must be packaged to provide complete mechanical and environmental protection. The package must also include means for bringing electrical connections in and out of the device and some provision for removing heat from the device. The methods chosen to achieve these results will directly affect the interconnection of semiconductor networks to form complete equipments.

The interconnection technique to be used in an end equipment is ultimately determined by the equipment designer. Only he can determine the relative weights to be ascribed to the important factors of size and weight, cost, maintainability and reliability. It is not likely that a universal technique will be developed to satisfy these widely different end objectives. This paper will describe a design where size and weight have been minimized at the expense of increased cost.

At some time in the future, it may be possible to fabricate entire equipments, or very large sections of equipments as a single unitary structure. This approach may be considered if self organizing systems which can tolerate large numbers of defective components can be devised, or if processing yields can be raised to a point very near perfection. At present, however, it is essential to build small groups of components which can be assembled to form the complete equipment.

Although no exact figures exist, it is believed that the optimum complexity for the individual package is a single functional circuit such as a flip-flop, logic element or a gate. Selection of a functional block of this type permits performance testing of the finished unit, which is always desirable and sometimes essential since not all of the individual components can be isolated for testing. The flip-flop shown in Figure 1 is near the upper limit for present circuit complexity. This package contains the equivalent of sixteen components.

The use of a package of uniform size makes it possible to connect the packages together with less wasted space between packages, although some space inside the packages is unused. For this reason, all of the digital networks

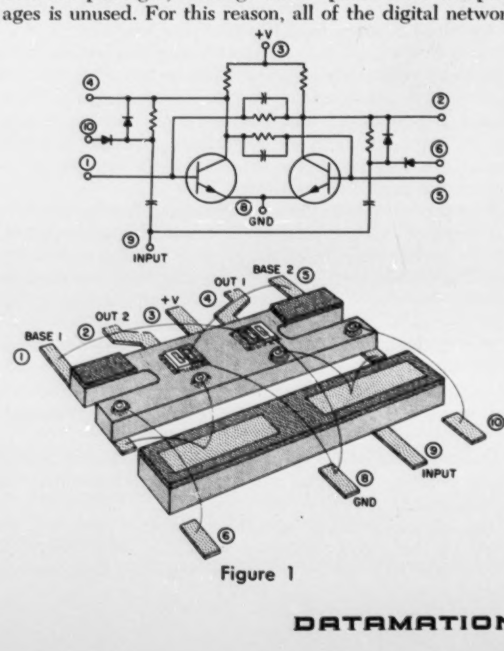


Figure 1

which have been made to date have been packaged in the case shown in Figure 2. The size of this package has been chosen rather arbitrarily. Its rectangular shape permits ten leads to be brought out on the two long sides with a spacing of 0.047 inches. A flat shape was chosen to permit optimum heat transfer from the silicon wafer to the outside of the case.

This package is assembled by the process shown in Figure 3. This process provides a complete glass-to-metal hermetic seal, which is believed to be essential for full protection of the device under severe military environments. Because of the very small mass of the package, it is not susceptible to mechanical shock.

The thinness of the package makes it possible to connect packages together either by stacking or by the use of flat layouts on an etched circuit board. Since the thickness of the package is about equal to that of the common circuit boards, the volumetric efficiency of this technique is quite low. It does offer good access to the packages for testing and maintenance and should be quite useful in designs where minimum size is not a requirement.

For either the stacked configuration or the flat version, some form of multiplane wiring is probably essential. It is not possible to specify the lead sequence from the packages since the leads must be connected inside the packages to the device as directly as possible. The external wiring must therefore have some provision for crossovers.

One multiplane wiring scheme which has been used with success is shown in Figure 4. Here the packages are stacked, and thin sheets of teflon with metal cladding are used to form the conductors. It is frequently desirable to separate the supply voltage wiring, which may be connected to all packages in a stack, from the signal paths which go from package to package. One sheet may be used for each supply voltage. These sheets are formed with a grid patters of conductors and holes. The first sheet is placed over the leads of the stack and the leads to be connected to the sheet are bent over and soldered to the sheet. Electrical and mechanical clearances are provided so that the other leads will pass straight through the sheet and will be insulated from it. A second sheet may then be added and connected. Some of the stacks which have been built have used four supply voltage sheets. The signal paths which are required are then formed on similar etched sheets which complete the remaining connections.

An alternate type of construction is shown in Figure 5. The teflon sheets are quite similar to those used in the original version, but small flaps have been cut which can

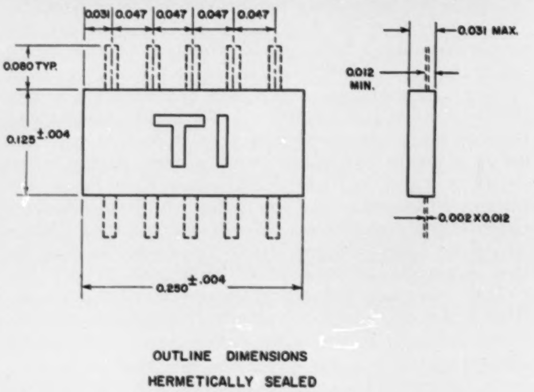


Figure 2

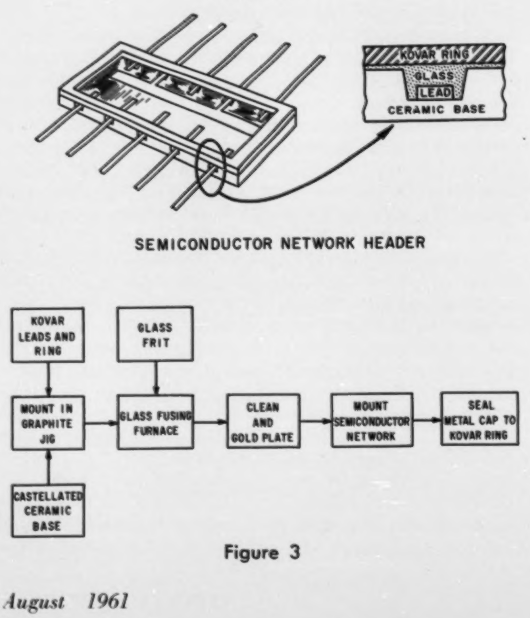


Figure 3

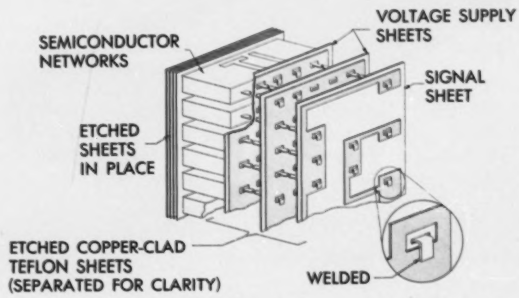


Figure 4

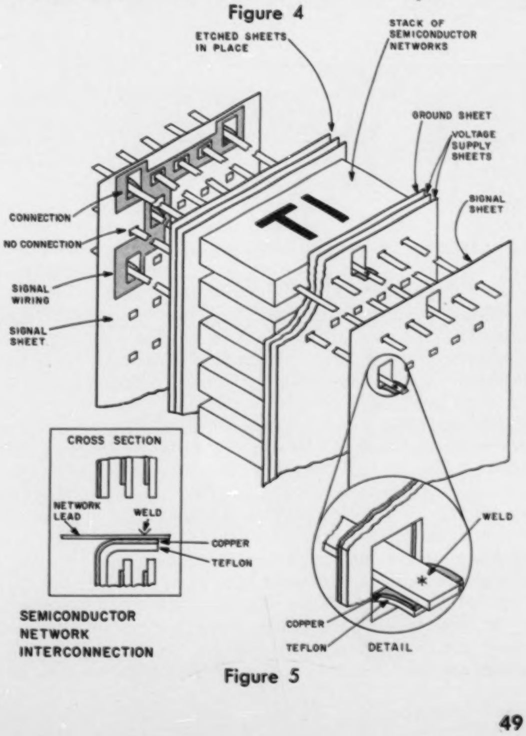


Figure 5

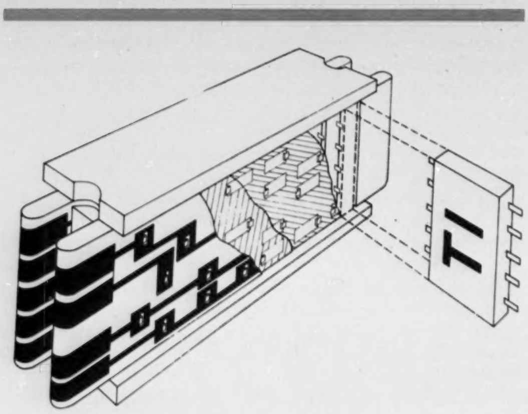


Figure 6

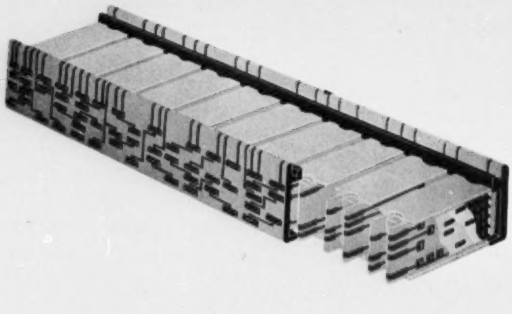
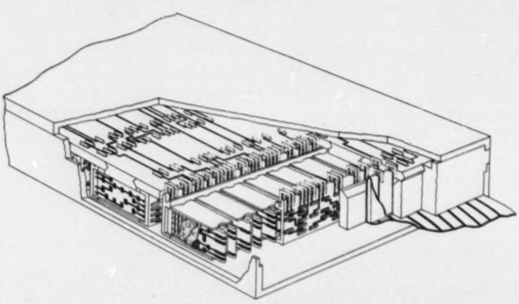
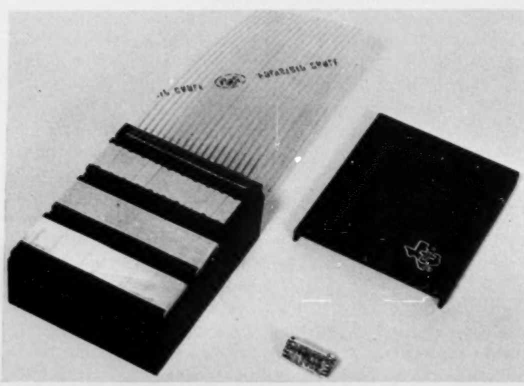


Figure 7



Figures 8 & 9



be bent to lie parallel to the leads with which they are to be connected. This version is particularly adaptable to welding. It has the added advantage that no bending of the leads is required and that all leads are available for use as test points after the stack has been connected.

Although defective packages have been replaced in stacks of this type, it would certainly not be attempted for field repair. The stack itself should be considered as the basic replaceable item. Although there is no single figure for optimum throwaway cost for present day military equipments, several studies have shown that the optimum is probably in the range of $200 to $500. It is believed that the cost of a ten to twelve package stack of networks will be within this range for production quantities of devices.

Since the stack is to form the replaceable element, it should be sturdy enough to withstand handling. It should also include a connector to permit easy replacement and isolation of the individual stacks for testing. One such arrangement which has been used is shown in Figure 6. An aluminum frame is used to hold the packages. The teflon sheets are used to provide connections between the packages. The ends of these sheets are then formed around the ends of the frames to provide the male portion of a connector. Flat side plates of aluminum are used on the frame to permit heat transfer from the stack. If required, aluminum foil strips may be placed beteen the packages and brought over to these plates to further reduce the temperature drop between the frames and the device junctions.

Stacks of this type which will accommodate twelve packages are 0.312 x 0.600 x 0.200 inches. Connections between stacks are provided by strips of connectors, which utilize a similar multiplane wiring scheme. A row of ten stacks is shown in Figure 7. The individual frame side plates are exposed so that the row can be sandwiched between thermal conductors. The edges of the multiplane wiring are again wrapped around an exposed edge of the strip to provide connections between rows.

These rows may then be plugged in to form large sections of an equipment or complete equipments, as illustrated in Figure 8. Multiplane wiring is used between the connector clips.

An assembly of 600 network packages is shown in the photograph in Figure 9. Although the finished equipment is to contain only 600 networks, a 20 per cent coverage has been provided, or 720 possible package locations. These have been provided in six rows of ten stacks. Three rows are visible in the photograph, with the other three on the bottom of the package. Thermal mockups of the assembly have been completed.

The size of the finished unit is almost exactly that of a package of regular cigarettes. It would contain about 8500 individual components in the 600 packages. Total volume required is slightly under 6 cubic inches, including that required for the case, internal heat transfer provisions, and connectors.

This design is not believed to represent the smallest, or the lightest, or the cheapest version possible for this equipment. Many different arrangements of these parts are possible, and some of them may well be more desirable. Different objectives, in particular, may suggest radically different methods of construction. The real significance of this design is that of an existence theorem — that it is possible to construct useful equipments from semiconductor networks which are orders of magnitude smaller than existing equipments.

This paper was originally presented at the Western Joint Computer Conference, May 9-11, 1961, in Los Angeles.

MAGNETIC DEVICES FOR DIGITAL COMPUTERS

by DUNCAN H. LOONEY, Bell Telephone Laboratories, Inc., Murray Hill, N.J.

The growth of modern digital computer technology has been greatly facilitated by the use of magnetic devices. Magnetic tapes, drums, and ferrite cores have proved extremely successful when used for the storage of information in computing systems. Of these, cores are used almost exclusively in high speed applications. The success of the core memory[1] may be attributed to three factors. Any word of information stored in the memory may be reached and the information read out in a period of a few microseconds. The cost per bit of information stored in the system is quite low. In addition, the completed storage systems are capable of reliable operation. Further development has improved the magnetic properties of the cores and uncovered new modes of operation of the memory arrays.

In addition to the improvement of the magnetic core and systems using the core, a number of other magnetic components have been proposed for use in data processing systems. Several of these devices have been developed and compete with the ferrite core. Usually these devices are aimed at either a reduced cost per bit or a decreased cycle time. In addition to the work to develop improved storage devices for erasible information, several proposals have been made for memories possessing non-destructive readout characteristics. A number of high capacity stores designed to hold semipermanent information have been reported.

the ferrite core

The magnetic material used in memory cores is characterized by a square hysteresis loop as shown in Figure 1. Information is stored by the sense in which the magnetization is directed, i.e., counterclockwise or clockwise. The material can be magnetized to either state by passing a current through the wire. When the current is removed, the material will remain magnetized. If the toroid is magnetized in the lower remanent state and a positive current is applied, very little magnetic flux changes direction until the current reaches the value indicated as I_k. The existence of this knee is important in that it permits the selection of one core out of an assembly of cores since a current of $2I_k$ will reverse most of the flux. When the current pulse is removed, the material relaxes back to the upper remanent state. If additional current pulses in the positive direction are now applied, the core will shuttle outward and, on the removal of these pulses, will return back to the upper remanent state. The flux change during the shuttle is very small compared to the flux change between the lower and upper states. The fact that a current of $2I_k$ produces a large flux change when the toroid is switched but only a small flux change when the toroid is shuttled, means that the size of the flux change may be used to detect the original remanent state of the core. Such an interrogation will destroy the information.

Since the core has proved successful as a memory device, a number of developments have been carried out to improve the performance of the core memory system. The objectives have been to increase the speed of access to information stored in the system or to improve the over-all reliability of the system. By increasing the threshold field required to alter the magnetic state of the core, it is possible to drive the core with much larger fields.[2] Since the speed at which a core is switched depends upon the excess field above that produced by I_k, shorter switching times are possible. By increasing the coercive field to about 3 oersteds, core systems may be made to operate with cycle periods of 2 microseconds.

The cycling period of the store may also be decreased by the use of impulse or partial switching of the core.[3] In this case only a portion of the flux in the core is switched substantially reducing the time necessary to read and write into the memory. Memory systems using impulse

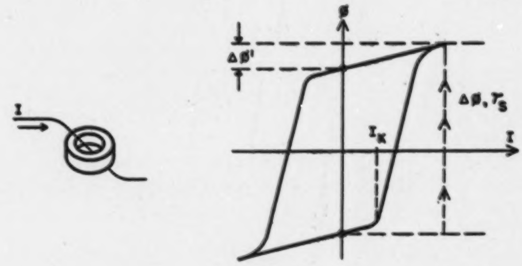


Figure 1

switching have been developed with cycle times of one microsecond or less.

A fast memory system employing two cores per bit of information stored has been studied.[4] Information is stored by the relative quantities of flux distributed between the two cores. A sense wire threads the two cores in opposite directions. Consequently, if one of the cores contains more flux than the other, the readout signal will have a polarity determined by that core. Partial switching may also be used with the resulting decrease in switching time. In linear selection systems, the drive current may exceed the threshold I_k by a factor greater than two and thus provide an increased drive field. Such a memory system is capable of a cycle time of less than one microsecond.

The reliability of the core memories has been improved. The two core per bit system discussed above does not depend upon the close control of the magnetic threshold of the materials used. As a result the system is relatively insensitive to variations of the drive currents. It is also less sensitive to variation of the ambient temperature than the

single core coincident current system. Additional effort has been devoted to developing special ferrite materials for use in single core per bit memory systems. For example, specialized materials with higher Curie temperatures have been proposed to permit the memory to operate over an extended range of ambient temperature.[5]

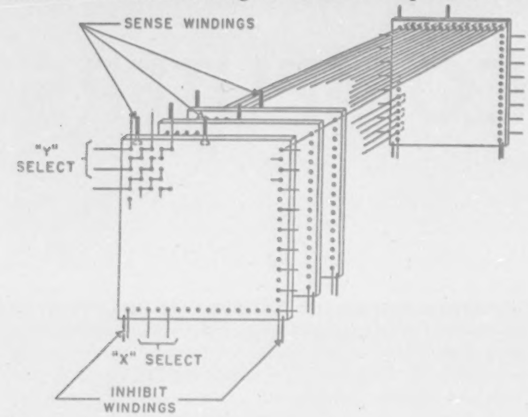


Figure 2

the ferrite sheet

The concept of the core as a storage element may be extended to a sheet of ferrite containing a number of holes.[6,7,8] The material surrounding each hole acts as a toroid. Such a structure forms an almost direct replacement for the core memory. In addition, it is possible to achieve extremely high packing densities using the compact arrangement of holes provided by the sheets. A memory module using ferrite sheets is shown in Figure 2. Each sheet can store 256 bits of information. The module is wired for coincident current operation by passing wires through the holes of each sheet as shown. Thus, an X wire is passed through the entire line of holes corresponding to the upper left hand position. The wire is brought back to the front through the next position in the row. The Y wires may be similarly wound. The sense wire may be evaporated, plated, or printed directly onto the sheet since the ferrite material is an insulator. It is also possible by more skillful techniques to place both an inhibit and a sense wire upon the sheet.

twistor

In both cores and sheets the information is stored in the material which surrounds a hole, i.e., in closed flux paths. The magnetic flux paths must be closed if the square loop is to be retained unless the material can be made in a form which has very low demagnetizing factors.[9] There are two well known geometrical forms in which magnetization can be retained in open flux structures. These are thin films of a few hundred angstroms thickness or wires which have a length to diameter ratio of the order of a hundred.[10,11] Bulk material can be processed into either of these two forms and retain its square loop.

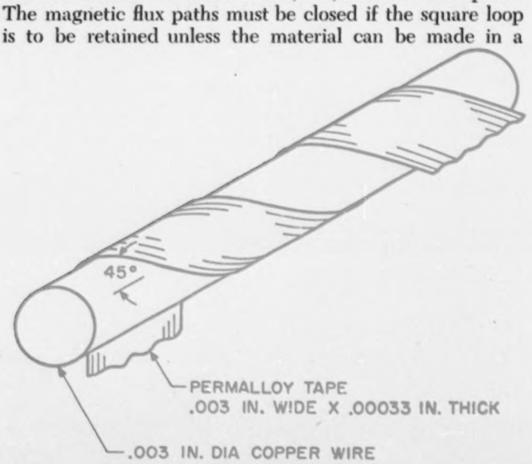


Figure 3

One form of magnetic wire, called the twistor, utilizes helical flux paths produced either by the introduction of a spiral easy axis of magnetization or by wrapping the magnetic material around a conductor in a helical winding as shown in Figure 3. The basic element has both the magnetic material as well as one of the required wires already fabricated into the device. It is then only necessary to supply the magnetic fields for the reading and writing operations. Single or multiturn solenoids perpendicular to the magnetic wire can be used to couple to the helical magnetization. Fabrication is simpler than with cores since the problem of threading conductors through a hole is reduced to one of placing conductors in close proximity to the magnetic material.

thin magnetic films

Several small memory systems have been reported using evaporated or electrodeposited thin magnetic films.[12,13,14,15,16] The film is evaporated onto a glass substrate, typically in the form of a circle of two to four millimeters diameter with a thickness of about 1,000 angstroms. The material is usually a permalloy of about 20% iron and 80% nickel. Such a film is not magnetostrictive, has a low anisotropy, and has a very square loop. Investigation of the flux reversal processes of such films has shown that it is possible to achieve switching speeds which are much greater than have been obtained using ferrite cores in coincident current memory systems. The magnetization reverses by a very fast rotational mechanism. Such a memory element is desirable when high speed operation is required. In addition, the possibility of evaporating large number of films and the associated electrical conductors offers fabrication advantages. The magnetic material has been prepared in continuous sheets, cylinders, and rectangles, as well as circular discs.

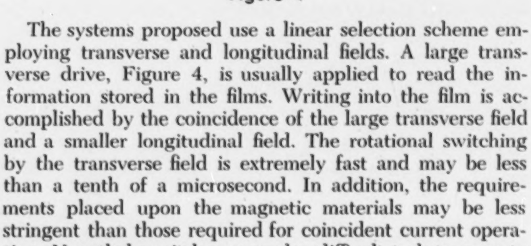


Figure 4

The systems proposed use a linear selection scheme employing transverse and longitudinal fields. A large transverse drive, Figure 4, is usually applied to read the information stored in the films. Writing into the film is accomplished by the coincidence of the large transverse field and a smaller longitudinal field. The rotational switching by the transverse field is extremely fast and may be less than a tenth of a microsecond. In addition, the requirements placed upon the magnetic materials may be less stringent than those required for coincident current operation. Nonetheless, it has proved a difficult task to operate large arrays of thin films.

a comparison table

In order to compare some of the properties of the devices which have been discussed, Table I has been compiled. The properties listed in the first column are typical of a ferrite toroid of 50 mils O.D. and 30 mils I.D. The total current necessary to read the core at a speed of one μsec

is 0.6 amp. The inhibit current, used to write a zero into the device, is 0.3 amp. The back voltage is 70 mv and the output voltage is the same value. Since the parameters of typical ferrite materials are temperature sensitive, the operating temperature range of a core is small. The propagation time per bit places a limit on the size of the memory module for a particular operating speed. In a typical core memory, the propagation time per bit is 0.03 mμsec. Although the physical size of typical wired arrays is designated as medium, special techniques may be employed to reduce this size.[17] For comparison purposes the cost of a core memory is designated as medium. For store capacities of less than 10^5 bits the cost of the store may be determined largely by the associated electronics.

The second column in the table lists the characteristics associated with a typical ferrite sheet. The dimensions are: hole diameter 25 mils, center-to-center spacing 50 mils, sheet thickness 20 mils. The properties listed are almost all obtainable from the corresponding core properties by simply scaling the dimensional sizes of the units. The switching time can be made one microsecond. The reduced magnetic path lengths of the sheet result in a read-current of 0.5 amp and an inhibit current of 0.25 amp. The cross section of the active magnetic material around the hole is the same as in the core, and consequently, the back emf and the output voltage are each about 70 mv. The temperature range of operation of a ferrite sheet memory should be the same as that of a core memory. The propagation time listed is estimated to be the same as for a core. Although the size of the bit is reduced, there is additional ferrite material present which contributes to the delay. The principal advantages of the sheet memory are small physical size and low cost. It is one of the smallest magnetic matrix memories which can be fabricated easily. In applications where miniaturization is important, the sheet memory should receive serious consideration. Finally, the manufacturing cost of the sheets is considerably reduced compared to that of cores. The production of a sheet of 256 bits (256 holes) is very similar to the operation of producing a single ferrite core. Similarly, the testing of the bits in a sheet can be automatic, and thus the testing of 256 holes replaces the testing of one hole. Assembly time is also reduced by wiring many sheets simultaneously.

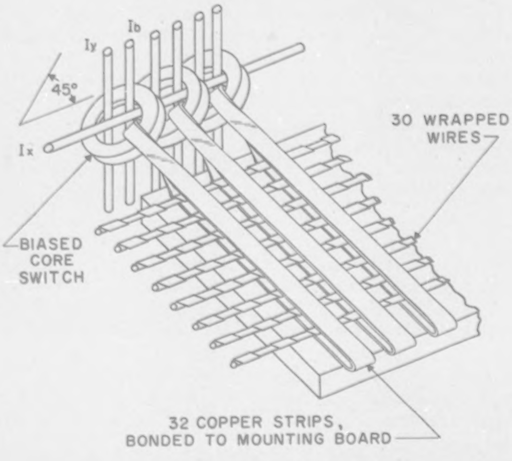


Figure 5

The numbers listed in the third column of Table I refer to the twistor structure shown in Figure 5. Flat Permalloy tape of about 1-sq. mil cross section is wrapped

PROPERTY	CORE	SHEET	TWISTOR	FILM
SPEED, μSEC	1.0	1.0	1.0	0.1
CURRENT				
READ, AMP	0.6	0.5	3.0	0.25
INHIBIT, AMP	0.3	0.25	0.06	0.10
DR. VOLTAGE, MV	70	70	1	1.0
OUT. VOLTAGE, MV	70	70	15	1.0
PROP TIME MμSEC/BIT	0.03	0.03	0.06	0.005
TEMP RANGE	S	S	L	L
SIZE	M	S	L	S
COST	M	S	S	S
REALIZED CAPACITY	10^6	10^4	10^4	10^3

Table I

around a 3-mil copper wire to form the twistor. The read field is supplied by a single turn copper solenoid of about 150 mils length. The switching time can be made one μsec. In this case, the read current in the solenoid is about 3 amp. The current to inhibit the switching of the device for writing zeros is passed up the center wire of the twistor and is only 60 ma. The back emf during reading is 1 mv and is normally a negligible quantity. Since the Permalloy tape wraps around the copper wire about 15 times within each solenoid, a transformer action is obtained. The circular component of the flux which is sensed by the inner copper conductor is then about 15 times the longitudinal component. A twistor memory which utilizes Permalloy material is expected to operate over a wide temperature range.[18] In general, the bit length of a hundred and fifty mils is comparable to that of the cores, but it is usually necessary to have a buffer region between bits which increases the over-all bit size. Consequently, the propagation time per bit is increased to 0.06 mμsec. As a result of the buffer region the physical size of the memory is also increased. It is anticipated that the cost of manufacture of such a memory will be cheaper than that of a core memory.

Finally, the properties of a high speed thin film memory are considered in the last column of Table I. In this case, a fast switching speed of about 0.1 μsec is possible. The reading and inhibiting currents will depend upon the actual structure which is used as well as the size of the magnetic film bit. For a rectangular film[19] a typical value for the reset current would be 0.250 amps. The back emf and the output voltage will be about 1.0 mv. The films are composed of permalloy materials and, therefore, the memory should be capable of operation over a wide ambient temperature range.[18] The reduced propagation time is a consequence of utilizing the small dimension of the rectangle. The plate-like memory elements provide an opportunity to use etched wire techniques in place of the threading techniques used to assemble core memories.

The ferrite core is the standard storage device in commercial computers today. Million bit capacities are easily obtained while the use of two core per bit technology has extended the cycle time of the stores to a fraction of a microsecond. Several ferrite sheet stores with capacities of 50 kilobits have been tested satisfactorily. The ferrite sheet has a potential economic advantage which can be realized in high level production. A number of twistor stores of 12 kilobits capacity have been manufactured and are noted particularly for their reliability. The achievement of high storage capacity and short cycle periods has been complicated by the necessity of writing and sensing on the same twistor wire. Development effort in thin film memories has been directed to stores with very short cycle periods. Significant advances in the understanding and preparation of the magnetic materials have made it possible to fabricate arrays by a number of techniques. Several stores of a few kilobits capacity have been reported, but the availability of satisfactory access and

sensing equipment has limited the development of larger stores. Although the thin film magnetic array may be relatively inexpensive, the cost of the associated circuitry for high speed operation will be larger than that of the typical core store.

semipermanent memories

Although the ferrite core is used extensively for the storage of variable information, a number of stores have been reported which retain information semipermanently. The data may be stored by electrical or mechanical techniques. Then electrical interrogation can be completed as many times as desired without destroying the information placed in the store. Thus, the program or set of rules governing the operation of the data processing unit can be placed in such a store. In addition, constant data or tables of numbers may be conveniently stored and used repetitively.

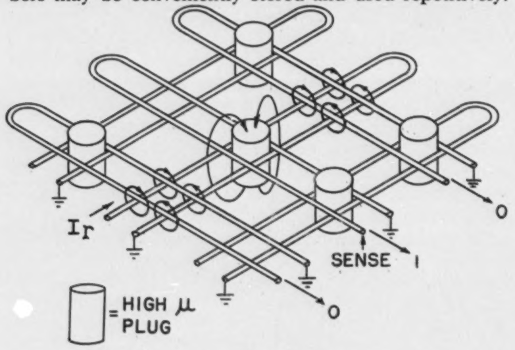


Figure 6

The ferrite peg store[20], thet metal card store[21], and the permanent magnet twistor[22] are mechanically changeable stores. The peg store, Figure 6, consists of a matrix of horizontal and vertical wires electrically insulated from one another. A current pulse flowing in the horizontal wire will normally have no inductive field coupling to the vertical wires. If a peg of magnetic material is placed at the intersection of the two wires the symmetry of coupling

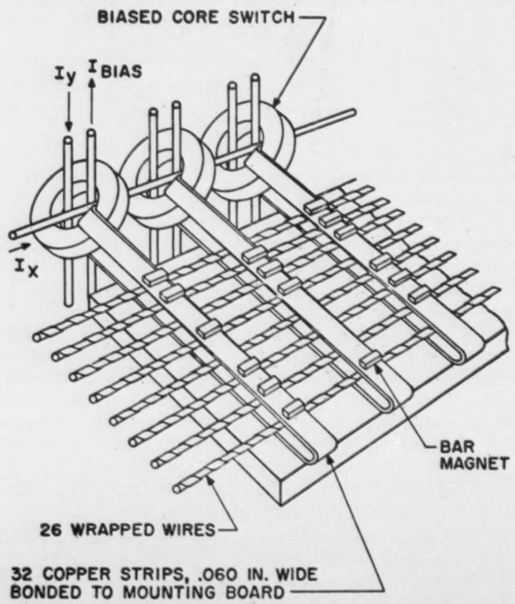


Figure 7

is disturbed and a signal is induced from the horizontal to the vertical wire. The presence or absence of the ferrite peg may be used to specify the information store. The memory system uses only inductive coupling and consequently provides extremely fast operation. Since the energy coupled from the horizontal to the vertical wire is linearly related to the addressing current, a very large memory will require an extremely good access technique. A store has been completed with a capacity of 200,000 bits with an access time of 0.1 μsec.

The metal card memory also utilizes the mutual inductance at the crosspoint of two wires. The coupling is altered by the presence or absence of holes in a metal card. A store of 20,000 bits capacity with cycle period 30 μsec has been made. Larger capacities and shorter cycle periods are feasible. Similar techniques have also been proposed which utilize capacitative coupling.

A card changeable nondestructive readout memory, Figure 7, may be made of twistor wire and small permanent magnets. An array of bar magnets, typically 60 mils long, 20 mils wide, and 1 mil thick, is located on a plastic card. The card is registered over an assembly of copper solenoids containing a set of twistor wires. The bar magnet biases the magnetic material of the twistor. Consequently, if a current pulse is passed down the copper solenoid, the magnet will inhibit the switching action of the twistor. If there is no magnet present, the field will switch the twistor wire and produce an output signal. Thus, the twistor-solenoid array provides access to a set of permanent magnets. The information then is stored in the presence or absence of a permanent magnet.

A large solid state store has been built utilizing the above principle. The store has a capacity of 1.4 million bits and a random access cycle period of five microseconds. The output signal is a few millivolts. The units are extremely insensitive to ambient conditions. Typically, the the drive currents may vary about ±8%.

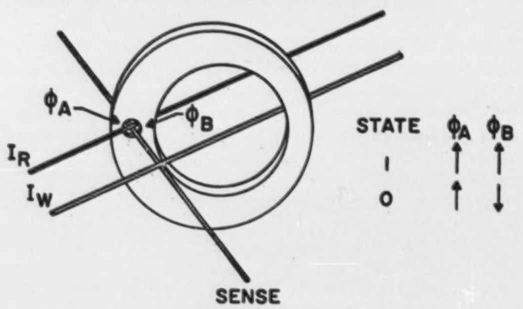


Figure 8

The transfluxor, Figure 8, is a multiaperture device into which information is written by electrical currents. It consists of a large ring of ferrite.[23] A small hole is located in the ring. Information is written into the large ring by means of normal coincident current techniques. The information stored in the ring is interrogated by pulsing the magnetic material surrounding the small hole. Thus, information is stored in the large ring but only the fraction of material surrounding the small ring is interrogated. The read operation is not limited to currents of two I_k if a linear selection scheme is employed. The technique has had limited applications.[24]

The Bicore[25] is a similar scheme in which the "permanent" magnet and the sensing material are two evaporated thin films in close contact. By utilizing a structure similar to Figure 4, the state of magnetization of the permanent magnet may be altered electrically. A store with a capacity of 32,000 bits and a random access cycle period

of 1.5 μsecs. has been completed and extensions in speed and capacity are being pursued.

SEMIPERMANENT MEMORIES

MECHANISM	EXAMPLES	OUTPUT
PRESENCE OR ABSENCE	PMT	$V_0 = k(I - I_0)$
	METAL CARD	$V_0 \alpha \frac{dI}{dt}$
	FERRITE PEG	$V_0 \alpha \frac{dI}{dt}$
FRACTIONAL READOUT	TRANSFLUXOR	$V_0 = k(I - I_0)$
	BICORE	$V_0 = k(I - I_0)$
QUADRATURE READOUT	TENSOR	$V_0 \alpha I^2 f$
	FLUXLOCK	$V_0 \alpha I^2 f$
VARIABLE PERMEABILITY	DEMAGNETIZED CORE	$V_0 \alpha \frac{dI}{dt}$

Table II

Table II summarizes the major characteristics of many of the different techniques being investigated for the storage of semipermanent information. Several additional devices are listed although they have not, as yet, been as successfully utilized in large stores. However, the information stored in these structures can be altered electrically in relatively short times.

The most successful technique is to store information by the presence or absence of material in some form. The memory can only be changed by mechanically inserting or altering the storage material. The permanent magnet twistor (PMT), the metal card, and the ferrite peg stores are examples of this approach. All three utilize magnetic or inductive coupling. Flying spot and capacitor stores are in the same basic category but do not employ magnetic effects.

In the remaining three mechanisms listed in the table, the information is stored in the direction of magnetization of the material. The mechanism refers in these cases to the technique of interrogation employed. In the transfluxor, information is stored in a large ring of ferrite containing a small hole. Only the ferrite surrounding the small hole is interrogated to determine the sense of the magnetization in the large ring. In the bicore element one of two closely coupled films is switched. Quadrature readout or the sensing of the direction of the magnetization by the application of a field transverse to the magnetization is employed in the tensor,[26] and the fluxlock.[27] Finally, since the permeability of magnetic material is determined by the magnetic state of the material, it is also possible to store information in a magnetized or demagnetized core.[28]

The various mechanisms employed for storage lead to three basic types of output signals as shown in the table. The first, which is associated with the permanent magnet twistor, the bicore, and the transfluxor, is identical to the normal irreversible switching used in variable memory devices. These structures have advantages in that the output signal is large and fairly long in the duration, typically about 1 μsec. As such, they simplify both the access and the sensing circuitry. However, the devices are limited to cycle times comparable to those of the core memories. The quadrature readout and the demagnetized core both depend upon permeability coupling of the magnetic material. The output signal is generated only during the rise time of the applied pulses or during the time in which an alternating frequency is present. Such devices are particularly useful for extremely high speeds of operation. However, it is usually necessary to utilize refined access equipment and more complicated sensing circuits. Consequently, the speed may be obtained only at an increased cost per bit.

summary

Properties of a ferrite core and a number of new devices have been discussed and compared to one another. Usually, the system objectives are to increase the speed of the device, reduce the drive currents and powers, or increase the operating temperature range. These functions must be achieved at no additional expense or, if possible, at a reduced cost. In small memories, a special device can be used at a cost penalty. In large memories the economic considerations are overwhelming and only devices which are cheap compared to a core can be considered. There will always be computer systems which will range widely in size and speed. Consequently, there will always be a demand for new devices made to fit into both the size and speed range of memory systems required for the computers.

Magnetic structures have been studied as memory devices for semipermanent information. Several stores have been reported and a number of additional techniques are being investigated. The development of fast random access systems for storing semipermanent information will become another major achievement of the magnetic components.

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TUNNEL DIODE POTENTIAL in computing

A PHILCO FORECAST

**by C. D. Simmons, Manager, Commercial Engineering Dept.
Semiconductor Operations, Philco Corp., Lansdale Div.**

Early forecast of tunnel diode applications were strongly oriented toward computer logic. True, these forecasts were carefully hedged about with admissions that the device needed improvement. Nevertheless, the excessive power requirements of today's high-speed logic circuits have brought our investigations to the point where we can state quite frankly that circuits using low-current gallium arsenide diodes for coupling elements and backward diodes for unilateralization elements now permit the design of practical high-speed logic systems operating at extremely low power levels.

Practical logic circuits have been built, and tests show that these circuits allow for a fan-in and fan-out greater than 3. These logic circuits will operate at clock rates in excess of 10 mc, with a total peak consumption per stage of less than 4 mw. Such figures may be called "startling" in that they reveal a 25 to 1 improvement over power consumption of conventional circuits operating at the same speed.

Use of backward diodes in conjunction with tunnel diodes and conventional high-speed MADT's allows the circuit designer to use "worst-case" methods and still meet the desired conditions of high clock rates and lowered power consumption.

Large-scale computer memories have plagued designers to the point where the tunnel diode's characteristics have been attractive. Up to the present time, though, high cost of the device has made the interest largely academic. Philco investigations have led to a prototype of an extremely low-cost tunnel diode package which allows us to forecast advent of large-scale, high-speed tunnel diode memories not only practical but economically sound. We feel that this will be one of the most important large-scale applications of tunnel diodes in the next few years.

From RCA Laboratories

A THIN-FILM TRANSISTOR

A microminiature, experimental thin-film transistor has been announced by Dr. Paul K. Weiner of the RCA Laboratories in Princeton, N. J.

With further development, Dr. Weiner feels that this innovation will permit extreme simplicity in the arrangement of computer circuits greatly reducing their size. He believes, "This is the first time that transistors having useful performances have been produced entirely by the thin-film technique of evaporating all materials upon an insulating base; in this case, glass."

The active material used in the transistor is cadmium sulfide, a compound with considerably greater insulating properties than the germanium silicon, and other semiconductor materials.

In making the thin-film transistors, an evaporation process is used to deposit successive thin layers of cadmium sulfide and metal on a glass plate, creating a device that is only a few ten-thousandths of an inch thick. In the evaporation process, the cadmium sulfide crystals and the metal are heated in successive steps in a vacuum, turning to vapor that is collected by condensation on the glass.

By using a special mask to cover portions of the plate during the process, the metal layers are deposited in a pattern that forms the electrical contacts needed to operate the transistor.

In conventional transistors having comparable functions, electrons flow more or less freely through the semiconductor material between two of the contacts, and the third element provides control by reducing the flow in varying degrees. The operating principle of the experimental thin-film transistor is exactly opposite. The insulating properties of the cadmium sulfide hamper the flow of electrons between two electrodes, and the third element provides control by increasing the flow in varying degrees.

CBS Labs announce

CYLINDRICAL THIN-FILM FOR BINARY STORAGE

A new thin-wall cylindrical film memory device, reportedly far superior in performance to conventional devices, has been developed by CBS Laboratories, a division of Columbia Broadcasting System, Stamford, Conn.

Outputs on the device for "One" and "Zero" range to several hundred millivolts as against 5 to 10 millivolts for conventional planar dot devices.

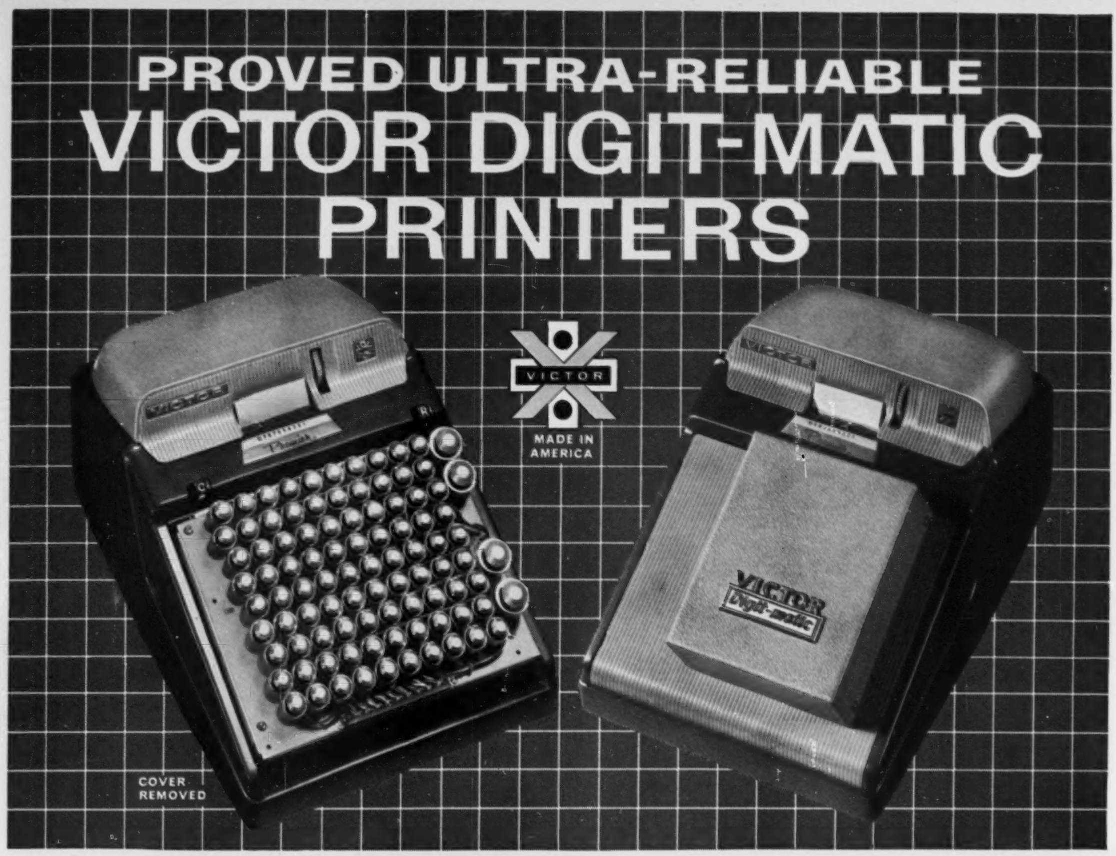
The cylindrical memory was designed by George Henderson, manager, Memory Devices Section, CBS Laboratories. CBS has also developed a new magnetic thin film memory material for binary information storage.

The new material, which is used in fabricating the cylindrical memory device, is a ternary composition of cobalt, nickel, and iron and can be plated without the stringent controls of temperature, pH, or vat composition which are now necessary in conventional plating.

Film thicknesses of 30,000 Angstroms for the rotational switching mode as compared to thicknesses of 1,000 to 4,000 Angstroms obtained with planar dots, have been found practical.

Samples have been given pure non-destruct operation on cycle times as low as 15 nanoseconds with outputs greater than 200 millivolts. Scratch pad operation is easily achieved. In fact, the non-destructive memories themselves can be operated quite simply as scratch pad memories, with cycle times from 15 to 20 nanoseconds.

A three-phase research and development program by CBS Labs is now being considered by a number of defense agencies. It includes the optimization of the cylindrical memory device design; further studies of the physical, mechanical, and electrical characteristics of the thin film magnetic material; and development of processing.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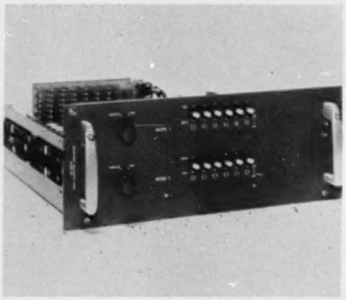
770 code converter

A new code converter, the 770 accepts binary code characters up to six bits in any combination and converts each character into an equivalent character in any other binary code arrangement. The 770 may be used in character recognition work, data display equipment, automatic checkout and in other dp systems. The 770 is available as a complete code convertor



or with the options of the 770D code detector and 770G code generator. Integrated as the code convertor, the 770D and 770G combine all functions of the code detector and code generator and accept 4, 5, and 6-level binary code. ELECTRONICS ENGINEERING CO. OF CALIFORNIA, 1601 E. Chestnut, Santa Ana, Calif. For information:

CIRCLE 200 ON READER CARD

tape reader

A military spec punched-tape reader utilizes 70 mm mylar tape and has been designed specifically for simultaneous processing of large amounts of intelligence – up to 132 parallel form "A" contacts rated at 28 V and 150 ma. A proven reliability of 99.99997% and readout speeds of nearly 8000 bits per minute is claimed. CHALCO ENGINEERING CORP., Gardena, Calif., For information:

CIRCLE 201 ON READER CARD

code tape punch/verifier

The model D875 universal code punch and verifier system has combined tape key punching and verifying functions into one system, which punches and verifies for all 5, 6, 7, or 8-channel tapes in any code structure. The D875 system consists of an alpha-numeric keyboard, a paper tape punch, a tape reader, and interconnecting control circuitry. Keyboard of the D875 is an extensively modified version of the IBM Card Punch. SYSTEMATICS, A DIV. OF GENERAL INSTRUMENT CORP., Hawthorne, Calif. For information:

CIRCLE 202 ON READER CARD

delay lines

A series of magnetostrictive delay lines, the FM 200-5000, has been designed to provide a delay of five milliseconds with a bit rate of 500KC. Included in the unit is a transistor driver, output amplifier and shaper which provides no insertion loss and an output pulse identical to the input. CONTROL ELECTRONICS CO., INC., Huntington Station, L.I., N.Y. For information:

CIRCLE 203 ON READER CARD

character generator

The TD-549 character generator can display up to 100,000 characters per second and can print over a million words per minute in any alphabetic language. The generator features 64 plug-in characters and codes, and accepts signals from computers, high speed tape readers and high speed data links. TRANSDATA, INC., P.O. Box 1369, San Diego 12, Calif.

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series 200 digital logic modules

New miniaturized series 200 encapsulated digital logic modules are rated for operation over the frequency range D.C. to 250 Kc., and all units are designed for operation over the MIL-E-5272 D temperature range (−54°C. to +71°C.) Each module is epoxy-encapsulated in a color-coded epoxy shell, of standard modular dimensions and all terminals are on a

standard .200 inch modular grid for ease of printed circuit layout. HARMAN-KARDON, INC., DATA SYSTEMS DIVISION, Ames Court, Plainview, New York. For information:
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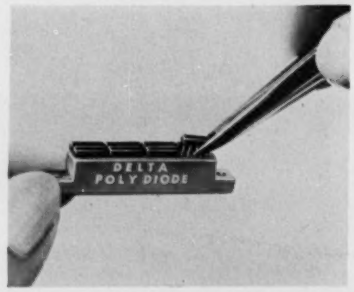
plug-in poly-diode

The size of a computer circuit may be reduced by 90% utilizing the plug-in poly-diode, it is claimed. The unit consists of up to five separate diode junctions, each with an individual lead, formed on a single silicon slice in a computer gate configuration.



Eight poly-diodes can be plugged into a special micro plug, each containing eight quad poly-diodes with 32 junctions and measures .160 inches by 1.5 inches. DELTA SEMICONDUCTORS, 835 Production Place, Newport Beach Calif. For information:
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silicon computer diode

A high speed silicon point contact computer diode is available for applications requiring fast switching speed and response. Forward characteristics of the MA-4121 diode are 10.0 milliamps at 0.55 volts (maximum) and 30.0 milliamps at 1.0 volts (maximum), with a reverse current of 200 microamps at −4 volts. The reverse recovery time is a fraction of a nanosecond and is governed by the wiring configuration. MICROWAVE ASSOCIATES, INC., Burlington, Mass. For information:
CIRCLE 207 ON READER CARD

hyspersyn electric motors

A line of hyspersyn electric motors has been designed to handle memory drums. Motors are synchronous and there is less than one-part-in-a-million drift over a period of five days working time. GENISCO, INC., BEKEY ELECTRIC DIV., 2233 Federal Ave., Los Angeles 64, Calif. For information:
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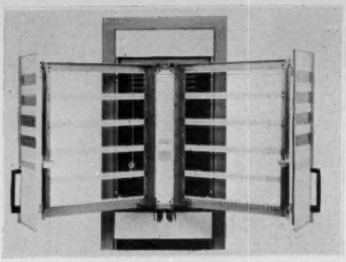
digital modules case

With provisions for as many as 200 signal lights, a new, rack-mounted digital modules case MC250, occupies



less than 30 inches of panel height in a standard 19-inch rack. It has a capacity of 250 modules, and is convenient for applications where all cir-

NEW PRODUCTS . . .

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micro-electronic modules

Two new micro-electronic BIPCO™ modules have been designed to convert binary coded decimal information to decimal form. The BIP-5501 converts the 1224 code to decimal form and the BIP-5502 accepts the 1248 code. Both units are mechanically identical and are designed for use in fully transistorized, low signal level systems. BURROUGHS CORP., ELECTRONIC COMPONENTS DIV., P.O. Box 1226, Plainfield, N.J. For information:

CIRCLE 210 ON READER CARD

switching mesa transistor

A high-speed, NPN silicon epitaxial mesa switching transistor, type 2N835, is capable of a typical over-all switching time of 47 nsec and features lower collector capacitance and reduced collector saturation voltage as a result of epitaxial-type construction. The 2N835 is intended for application in ultra-high-speed logic circuits including dp equipment where high temperature operation is desirable. MOTOROLA SEMICONDUCTOR PRODUCTS, INC., 5005 E. McDowell Rd., Phoenix 8, Arizona. For information:

CIRCLE 211 ON READER CARD

largest memory system

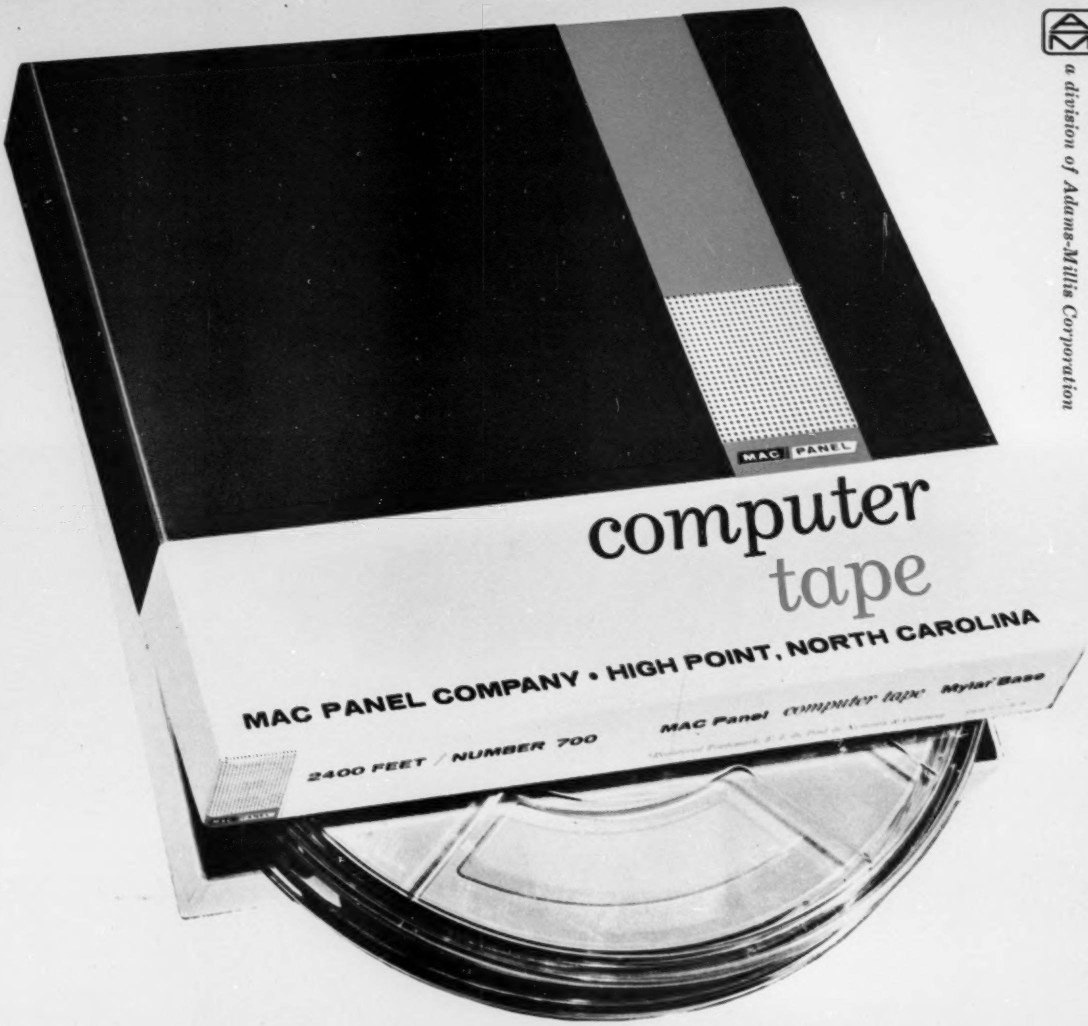
Model 8000K56R random access, core memory system is rated as the world's largest and is designed for operation over a temperature range of 15°C to 40°C with no temperature compensation required. The 8000 character, 56-bits per character memory operates

with a cycle time of six microseconds and access time of 2.6 microseconds. The system contains 448,000 GC MC-140 (50 mil.) Ferramic memory cores. APPLIED LOGICS DEPT., GENERAL CERAMICS DIV. OF INDIANA GENERAL CORP., Keasbey, New Jersey. For information:

CIRCLE 212 ON READER CARD

tape perforator

A medium speed motorized tape perforator can be used for mylar tape punching requirements for business systems in data handling, reduction, processing and storage. The modular constructed perforator operates in speeds up to 40 columns per second. Standard code channels: 5, 6, 7 or 8 code holes are used on standard tape widths of 0.687 inch, 0.875 inch and one inch and can be interchanged.



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MAC Panel Computer Tape, manufactured by the affiliate MAC-Netic Tape Company for use in IBM installations, marks the introduction of an entirely new realm of reliability of tape performance. Each reel has been tested to guarantee no drop outs . . . to give you greater insurance against tape-caused system malfunction. MAC Panel Computer Tape is magnetic tape developed with a new oxide formulation, an improved coating technigue on time tested Mylar*, and shipped to you in a damage protected, "handy-handle" package. You can depend on MAC Panel Computer Tape—available in standard lengths. Call your MAC Panel representative . . . he has the facts.

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CIRCLE 213 ON READER CARD

automatic circuit analyzer

Designed to test computer back boards, cables, wiring assemblies for continuity and hipot tests, the automatic circuit analyzer detects errors in large circuits. This equipment will

either accept instructions from punched cards or tape, or is self-programming. Compound block scanning permits 10,000 points checked in one hour. CONTRONICS, INC., 43 Leon St., Boston 15, Mass. For information:

CIRCLE 214 ON READER CARD

magnetic memories

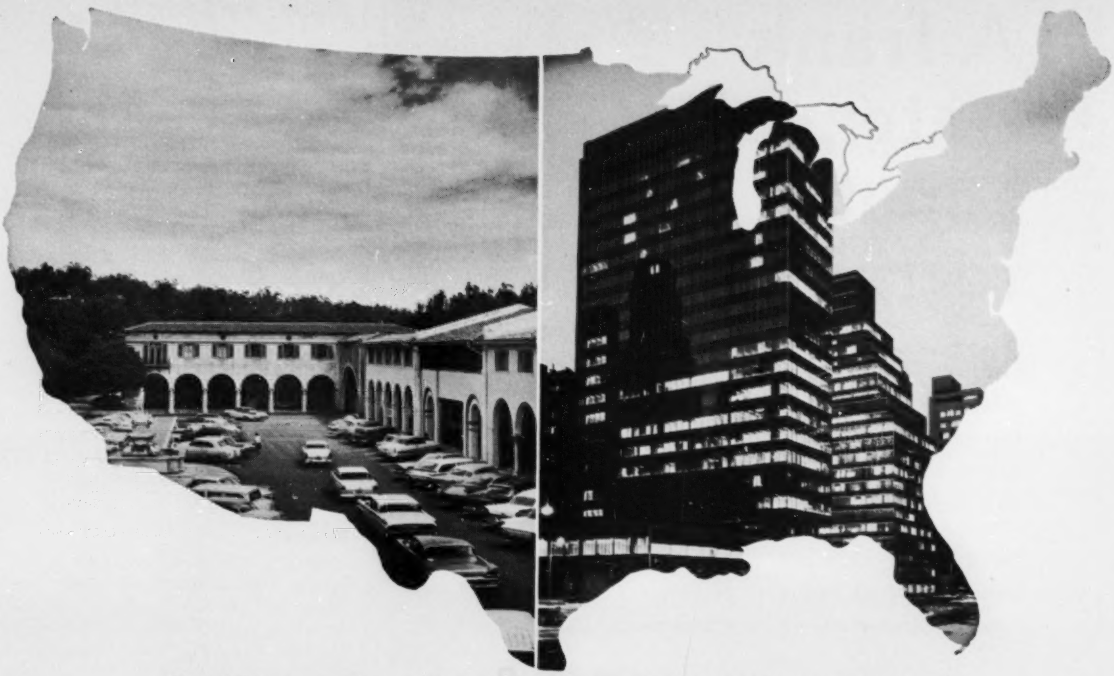
Type 3300 coincident-current, random or sequential access magnetic memories have a range of storage capacity from 128 to 4096 words and from 4 to 64 bits per word, for use in a variety of digital computer and dp systems. Solid state circuitry is used throughout and ferrite core stack plug-ins serve as the memory storage medium. Operating cycle times are as low as five microseconds. RESE ENGINEERING, INC., A and Courtland Streets, Philadelphia 20, Pa. For information:

CIRCLE 215 ON READER CARD

1 microsecond modular memory

A standard one microsecond modular memory employs subminiature magnetic ferrite cores, augmented by solid state logic and drive circuits. The solid state magnetic core array has a full read-write cycle time of 1 usec., with access time of 0.4 usec. The memory has a capacity of up to 1024 words, each 50 bits in length, but the capacity is expandable in modules of 1024 addresses and word lengths up to 200 bits. DAYSTROM, INC., MILITARY ELECTRONICS DIV., Archbald, Pa. For information:

CIRCLE 216 ON READER CARD



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Computer Sciences Corporation furnishes consultation, analysis, and programming in all areas of commercial and scientific data processing. Among CSC clients are such distinguished firms as Minneapolis-Honeywell, Ramo-Wooldridge, General Motors, RCA, and Southern California Edison. CSC is also available to serve you, whether you manufacture, use, or should be using a computer. A telephone call or letter will bring to your office some of the top computer talent in the country.

If you would like more information on the CSC approach to business and scientific problem-solving, write either of the offices below for an illustrated brochure.

CSC

COMPUTER SCIENCES CORPORATION

GENERAL OFFICES: MALAGA COVE PLAZA, PALOS VERDES, CALIF. • PHONE: (LOS ANGELES) SPRING 2-1179
NEW YORK DIVISION: 400 PARK AVENUE, NEW YORK CITY 22, NEW YORK • PHONE: PLAZA 2-6885

Challenging and rewarding positions exist at CSC for those who are outstanding in the computing and data processing field.

CIRCLE 40 ON READER CARD

NEW PRODUCTS . . .

tape reader

A militarized tape reader to MIL-E-4970 and MIL-L-26600, the type 271 is designed for slide or conventional mounting within a special console or standard rack. Reading speed is up to 300 characters/second with fully synchronous operation possible up to 220 characters/second. Fast advance/rewind is provided at 1000 characters/second. The drive module is coupled to the motor via a simple gear arrangement which may be altered for various speeds. With the exception of the clock pulses all data logic is NRZ in nature. FERRANTI ELECTRIC INC., Industrial Park No. 1, Plainview, L.I., N.Y. For information:

CIRCLE 217 ON READER CARD

relays

Two new microminiature relays, a half ounce, high accuracy solid state time delay, and an MS-approved high performance rotary crystal can, are available for computer uses. Where time delays with multiple output contacts are required, the two can be used in conjunction to perform the work of a conventional two-pole double-throw timing relay. The solid state device, identified as the TD-181, utilizes zener regulation for accuracy. The crystal can, identified as the M200, occupies less than ⅓ cu. in. and offers high resistance to shock and vibration. LEACH CORP., 717 N. Coney Ave., Azusa, Calif. For information:

CIRCLE 218 ON READER CARD

NEXT MONTH IN DATAMATION

"Computer Related Sciences At A University In 1975" will be author Lou Fein's projection and unusual appraisal of progress in computer education. Other features will include further words on COBOL, and a stimulating hardware discussion by Charles Adams. With continued interest in Gamma 60, DATAMATION will also offer an exclusive pictorial view of Europe's largest computer manufacturer, the BULL Machine Co., and as a special report: a survey of the BuBudget's EDP inventory and projection through June, 1962 (see Business & Science, page 12).

First “off-the-shelf” g
for low cost con

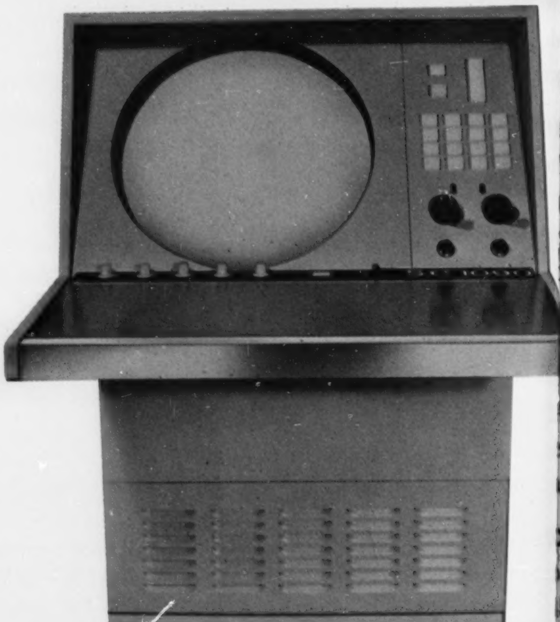
General Dynamics/Electronics’ new S-C 1090 is the first “off-the-shelf” computer display featuring high character legibility on a large CRT screen. The S-C 1090 incorporates an improved 19-inch CHARACTRON® Shaped-Beam Tube and is capable of displaying 1000 flicker-free, high-resolution characters simultaneously anywhere on the tube face. Thirty thousand or more characters per second may be displayed by the unit with extreme brightness, contrast and clarity.

MOST VERSATILE DISPLAY. The S-C 1090, operating either on-line or off-line, is designed to monitor digital computer systems and present data for decision or information purposes. Alphanumeric or symbolic characters, and vectors may be presented singly or in combination.

Maximum flexibility for various applications has been provided by a number of special modular optional features for the S-C 1090 display which include:

1. *Internal Test Pattern Generator*—permits complete set up and calibration without tying up the computer or data han-dling system, saving time and expense.

2. *Vector Generator*—capable of drawin straight lines between given points on th



See the S-C 1090 at the 1961 WESCON Show, Booths 201–203

tube face for graphical presentations.

3. *Format Generator*—reduces uni input requirements and doubles display rat

gh resolution display
puter monitoring

4. *Input Register*—provides storage for position and character selection information facilitating timing requirements.

5. *Offset & Expansion*—can enlarge any segment of tube screen to full screen size.

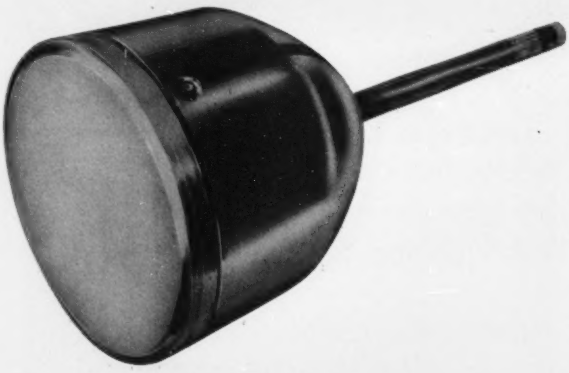
6. *Category and Feature Select*—allows selection of information for display without computer intervention.

UPERIOR CHARACTER FORMATION. The CHARACTRON tube's unique method of shaped-beam character formation offers proven advantages over line-segment, dot, or scan character techniques.

Symbols and characters are obtained by xtruding electron beams through stencilled penings in a metal disc called the matrix. After passing through the matrix, the haracter-shaped beam is directed to an ppropriate spot on the tube face.

OMPACT DESIGN. The S-C 1090 is a compact unit measuring 32 inches in width, 5 inches in height, by 66 inches in length ncluding an 18 inch work shelf. The unit's ow silhouette allows operators to actually ook over the top of the console for simultaneous viewing of the tube screen, projected large screen displays, or other data.

S-C 1090 APPLICATIONS. The S-C 1090 is capable of tabular, situation or graphical presentations and can be used in a wide range of computer intervention, monitoring and retrieval jobs. It is suitable for laboratory, simulation, Air Traffic Control and surveillance applications.



19-inch CHARACTRON Shaped-Beam Tube

For additional information on the S-C 1090 or other General Dynamics/Electronics readout and display systems, write General Dynamics/Electronics, Information Technology Division, Department B-45, Post Office Box 2449, San Diego 12, California.

GD

ENERAL DYNAMICS | ELECTRONICS

ON LINE... AND OFF

Author Gomer Wheatley offers DATAMATION readers this first installment in a random collection of irregular outbursts. Correspondents desiring a compassionate data link with Gomer are assured equal anonymity.

by GOMER WHEATLEY

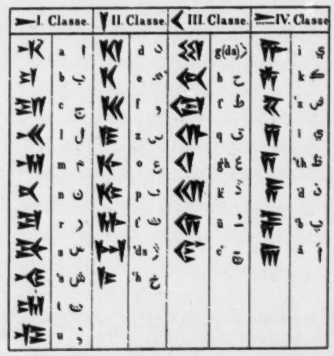
My real name is *not* Gomer Wheatley; it is Winifred Rogers, but my real name was systematically ignored by the people over in EDPM. They repeatedly confused my 7090 jobs with those belonging to a gentleman with the unlikely name of Will Rogers. While Will and I were working on the same floor of the same building of the same aircraft company we could easily exchange our incorrectly-routed bundles of printouts and stacks of cards, although the traffic often grew quite heavy.

Then Will was moved over to Building 6, a bus ride and four guard gates away. For a while EDPM seemed to have recovered their equilibrium and everything went swimmingly. But my temporary respite ended when one of my jobs couldn't be located for four days, and was finally recovered only because our observant courier happened to notice an unclaimed box labeled "W. ROGERS" gathering dust in Building 6.

At last one morning the courier inquired of me where to put the fourteen boxes of cards. But, Mister Anthony, I don't *own* no fourteen boxes of cards! Naturally, they belonged to Will. They were output from one of his programs, which apparently had stuck in a loop. Under the circumstances Will didn't want anything to do with them, and it remained for me to dispose of the cards. When I had filled all of the available wastebaskets, I put the rest in the CONFIDENTIAL burn box.

At this point I decided I needed a pseudonym. I chose Gomer Wheatley, one of W. C. Fields' favorite names, and have had no further trouble . . . from this source. For those of you who may at this very moment be considering using an EDPM pseudonym, I beg you not to use "Gomer Wheatley." It would only mean trouble for us all.

Furthermore, remember that a *nom de plume* cannot solve all the persistent problems involved in losing things in the murk of procedure. For instance, one of Gomer's recent lost printouts was eventually located at the telephone company: all of our printers were down that weekend.



A typical Wheatley printout compatible with microwave transfission and low flying aircraft.

Nor would a pseudonym have helped one of my office mates the other day. Her printout came back from EDPM with a handwritten note scrawled across the bottom of the last page which said:

"SORRY, NO PHASE 3 OUTPUT"

This deeply puzzled my office mate, because her program had been debugged and running for months, and phases 1 and 2 of the particular run in question had gone perfectly. She is an inquisitive person anyway, and her curiosity was further aroused by the mysterious nature of the note from the operator. So she got on the telephone, and several wrong numbers and busy signals later she had the answer: EDPM had been sent her program via microwave to another computer location, and, apparently, a low-flying airplane had garbled enough of the program in phase 3 to prevent its completion.

For men of vision

SOLID CAREER OPPORTUNITIES IN **BURROUGHS** ELECTRONIC DATA PROCESSING MARKETING

Waiting for you at Burroughs Corporation are some of the industry's most challenging and rewarding career opportunities. An extensive and purposeful research and development program has spurred the introduction of several major systems this year—including the pace setting new B 5000, the first computer specifically designed to implement problem oriented languages. There are more to come. A planned program of future releases will insure continuing growth opportunities. Substantial opportunities now await qualified personnel in the following positions:

Special computer representatives: To promote the sale of this advanced data processing equipment, working with experienced account representatives. Opportunities to advance are wide open because of Burroughs practice of developing management personnel from within. Salary plus override will be attractive to experienced computer sales representatives.

Sales technical representatives: To assist sales representatives in technical aspects of sales presentations and guide installations of systems. You will receive progressively more challenging assignments in either scientific or business data processing. You'll qualify with strong magnetic tape installation experience or sound punch card systems background, and receive a salary commensurate with experience.

Openings are available in major cities throughout the U.S. Call the manager of our office near you, or write in confidence to L. D. Staubach, Director of Marketing Placement, Burroughs Corporation, Detroit 32, Michigan.

Burroughs—TM

Burroughs Corporation

All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

CIRCLE 75 ON READER CARD

NEW FLOORING DEBUTS UNDER 900 SYSTEM

A new type of elevated flooring from Strato-Floor, has been installed at Addressograph-Multigraph's dp demonstration room recently opened in Cleveland.

The sub-structure of the floor is a grid support system which provides strength and rigidity without excessive weight or bulk. Modular 24" x 24" panels, are made of cross-laminated plywood, molded in plastic.

Deflection is minimized by use of steel stringers which are bolted to an adjustable jack. The floor can support a live load of 250 lbs. per square foot, and a point load of 1000 lbs.

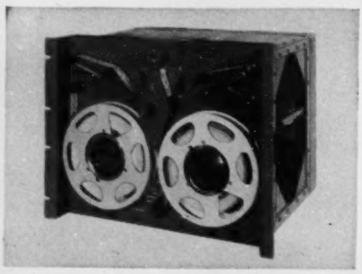
The triangle has been utilized in the design of the Strato-Tri-Jack to add greater strength support to the stringer.

On exhibit in the demonstration room is the AM series 900 EDP system which includes a file processor, tape transport units, card readers, a serial printer and line printer.

The A-B 943 file processor uses core storage and transistorized arithmetic and logical devices in modular form, tailored to meet the individual user requirements. Simultaneous reading, writing, and computing of data in unit or grouped record format is accomplished by means of control panels.

CIRCLE 111 ON READER CARD

...gives you greater reliability at less cost!



Using the revolutionary PMI printed motor, Photocircuits' line of Photoelectric Paper Tape Readers eliminates brakes, clutches, pinch rollers, solenoids — *and trouble*. Result: reliability that conventional readers can't match! Plus quieter operation, reduced tape wear, rapid reading and sustained trouble-free, error-free performance with maintenance at a minimum.

Photocircuits' readers offer you, at no additional cost—easy loading, jam-free operation over splices—tight tape and no tape protection—bi-directional reading—fast rewind in both directions—asynchronous reading at up to 300 characters per second—free running at 400 characters per second with the ability to stop on a character — and *magnetic switching*, which eliminates metal-to-metal contact in electrical switching of the reel servo motors.

Technical literature on the 300 R and the other Photocircuits' readers is yours for the asking. Get all the facts about how Photocircuits' advanced Tape Readers can perform for you and save your company money at the same time.

Photocircuits
CORPORATION
TAPE READER DIVISION
GLEN COVE, LONG ISLAND, NEW YORK

CIRCLE 31 ON READER CARD

COMPUTER POWER AT LOS ALAMOS

Stretch delivery cancels 1604 order

An air of speculative satisfaction surrounds the computer facilities at Los Alamos Scientific Laboratory. IBM's super computer, STRETCH, has been operational since May 13.

Pushed aside by this giant has been the news of a 7090 installation; cancellation of a 1604 order; deactivation of a 704, and talk of additions to the facility of even greater magnitude than STRETCH.

Dr. Bengt Carlson, group leader for Los Alamos' T1, surveyed this new system under his direction: "STRETCH is, of course, far superior to anything we have had here before, however, there are three basic areas where it has not met our expectations.

"The first and most obvious area was the delivery date. We had candidly anticipated perhaps a six month delay, but in reality it was ten months late going into operation. Second, the disc capacity is less than specifications by a factor of two. Originally we had expected a capacity of 4,000,000, but it is actually 2,000,000.

"This figure is certainly outstanding, but we did anticipate more. Finally, the disc speed is slower than first thought by a factor of two. We had been told to expect a speed of four microseconds, but the system is operating at eight microseconds," Carlson added.

STRETCH is now running on one eight hour shift. IBM has control of the system for the other 16 hours. This arrangement will be continued for a six month period, then the Laboratory will assume greater control. It is anticipated that within one year it will be operating on a 24 hour basis.

A hint of the progress the system has been making is shown in its first month's "good time" figures. For the week of May 29, it ran 92% good time; week of June 5, 84%; week of June 12, 88%; and week of June 19, 88%.

The coming of STRETCH was preceded by only a few weeks by the installation of a 7090 which is part of a three system order that the Laboratory placed when the future of STRETCH was uncertain. Another 7090 is scheduled for installation some time next year, having been postponed because of the delivery of the other units.

There is some doubt, however, that this system will go into operation. "At the present time there is just no money for the system, and unless something unexpected happens within the next four months we will have to cancel this too," Carlson stated.

The third system ordered was a CDC 1604, but this was cancelled when the STRETCH delivery was assured.

At work in other areas of the Laboratory are MANIAC II, two 704's, two 1401's, two analog computers and a 650 that is scheduled to be replaced soon by a 1620. A third 704 was deactivated with the installation of STRETCH.

The decision to cancel the 1604 before the 7090 was based more on the specialized situation at Los Alamos than on the ability of either system.

"To bring in another manufacturer's system would mean new personnel and retraining of some of the present staff. At this time, we are in no position to provide either housing or any other necessary facilities for them.

"We have been looking closely at the 1604, RemRand's 1107 and the CDC 6600, but there is certainly nothing definite about our investigation and discussions," Carlson concluded.

NEW FIRMS IN DP

—Five C-E-I-R executives have left the firm last month to organize their own company, a programming service house known as Computer Concepts, Inc., in Washington, D.C.

Four principals in the new organization include: Howard Morrison, formerly director of management services for C-E-I-R; William Witzel, C-E-I-R sales manager; Beryl Blickstein, manager of computer systems for C-E-I-R, and E. Martin Solomon, member, corporate staff of C-E-I-R's new Technical Information Processing Division. The one employee of the new firm is Burt Condriet, formerly deputy director for C-E-I-R in Houston.

According to Morrison, Computer Concepts will create and sell "off-the-shelf" programming packages for small business data processing; machine translation, site location and feasibility studies, etc. An important field for CC's efforts will concern the evaluation of effective use of existent computing power at various installations.

—Logicon, a new computer systems engineering firm, in Redondo Beach, Calif., has been established by a group of eight engineers formerly in the Computer and Guidance Department of Space Technology Laboratories. The new firm will work in the area of computer controlled guidance and control systems and plans to develop special purpose computers and digital systems.

—Specialization in the development of advanced materials and technology in the field of magnetic tape for data processing is the intention of the Memorex Corp., a newly founded northern California electronics firm. The company's initial production will be a line of high precision, thermal setting magnetic tapes to be ready for marketing early next year.

Temporarily located in Mountain View, Calif., the company has an initial capitalization in excess of $1,000,000, and plans to move to a 200,000 sq. ft. facility presently under construction in Mission Industrial Park, Santa Clara.

Founders of Memorex were formerly with Ampex in Redwood City. They are Laurence L. Spitters, Arnold Challman, Donald Eldridge and W. L. Noon.

new DATAMATION literature

ISO: A 64-page brochure details the work of the International Organization for Standardization (ISO), its technical committees and standards recommendations. The first edition, published in conjunction with the ISO General Assembly meeting which was held recently in Helsinki, gives information regarding activities and projects under consideration. Member bodies, administration, general information, proposals about the technical committee operations are listed. The main body of the text is in both French and English with the preface and technical committees also printed in Russian. For a copy of this brochure send $4.80 to ISO, AMERICAN STANDARDS ASSOCIATION, 10 E. 40th St., New York 16, N.Y.

PAPER TAPE TO MAGNETIC TAPE: A paper-tape to magnetic-tape converter, adaptable to the 704 and 709, consisting of two racks of electronic equipment designed to transcribe seven-channel digital code on punched paper tape to seven-digital code on magnetic tape is described in this 16-page booklet. Description of operation, as well as features, are included. For a copy of this bulletin send 50c to UNITED STATES DEPT. OF COMMERCE, Washington 25, D.C.

KINEPLEX: A new 24-page illustrated booklet highlights the Kineplex data transmission system. Creation and testing, fundamental theory and operation, background, application and basic system configurations are included. Another report describes new equipment designed to provide global digital communications when used with telephone and radio facilities pertinent to recent developments and applications of Kineplex. COLLINS RADIO COMPANY, 2700 W. Olive Ave., Burbank, Calif. For copies:
CIRCLE 262 ON READER CARD

FINDAFACT 2510: A new brochure describes the Findafact 2510 data retrieval system, a high-speed transistorized DP system whose three basic operating modes are tape file generation, data retrieval and tape file maintenance. Complete specifications are listed including the 12 record block length, 80 character record length, ¾" interblock gap and 12 microsecond access time per character. RESE INFORMATION SYSTEMS, A and Courtland Streets, Philadelphia 20, Pa., For copy:
CIRCLE 263 ON READER CARD

TAPE RECORDER BIBLIOGRAPHY: A bibliography of magnetic tape recorder equipment from 1954-1960, is now available. For a copy of this eight-page booklet send $1.00 to KINELOGIC CORP., 1256 No. Fair Oaks Ave., Pasadena, Calif.

PRODUCTION CONTROL: A bulletin contains information on the GE 3101, a data accumulation and communications system that transmits various remote input areas to a central point. Power requirements, weight, size, and features are included. Also available

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"OPPORTUNITY"

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DIRECTOR DATA PROCESSING SYSTEMS — To $40,000

Ph.D./EE—emphasis on Math. Top Administrator experienced in military applications of digital computers. Analyze, evaluate programs and planning of military as related to digital computers. Act as consultant to V.P. Engineering and other high level management.

SPECIALISTS—CIRCUIT DESIGN AND THEORY — To $25,000

Ph.D./EE/Math—Thorough knowledge of circuit logic and familiar with analog-type circuitry, communications information theory and basic network theory. One specialist with circuit logic on digital-type circuitry related to computer design.

E.D.P. CONSULTANT — To $25,000

Corporate level for multi-plant organization to analyze present systems and procedures and make recommendations to centralize.

SALES MANAGER — To $22,000 + Profit Sharing + Stock

To maintain existing business and develop new customers for the company's services and skills in the areas of: Systems Engineering, Equipment Development, Programmed Teaching, and Product and Market Planning. This man will develop a marketing program and direct the efforts of the Sales Staff to achieve the goals established. He will guide the preparation of an advertising sales campaign. This is a top-flight spot. He will report to the President.

PROGRAM MANAGER — To $20,000 + +

Background should include at least a BS/EE and several years of broad systems experience. Should be thoroughly familiar with advanced analog and digital hardware as well as with large system integration and application. As a Program Manager, will assume major responsibility for developing, presenting, and co-ordinating engineering and development efforts in connection with multi-million-dollar data systems programs.

SYSTEMS ENGINEER (Senior) (3) — To $20,000 + Profit Sharing + Stock

Synthesizes designs for large scale complex computer systems. Requires thorough understanding of computer operations at the block diagram level. Understanding of timing considerations necessary and logical design experience helpful. Knowledge of operation (functional) of input/output devices and use of computer in on-line situations desired. Should be able to define program and system requirements and write specifications from broadly stated objectives and be able to break down complex problems into major, relatively independent sections which can be handled by less-senior personnel.

SYSTEMS ANALYSTS — $20,000

EE/Math Deg. Min 2-10 yrs exp. Analysis of data to develop comprehensive systems and full responsibility for programming.

APPLICATIONS SPECIALIST/SENIOR PROGRAMMER — $18,000

Math/Physics. Aero or E.E. Min 10 yrs professional exp in (a) programming of scientific and/or process control problems for small to medium binary computers. (b) Systems Analyses or design of launch control and check-out equipment for a large missile or space vehicle system (c) operations analyses in the customer's facility. Ability to work well with other people and to assume role of technical leadership. *Not Sales* job.

LOGIC DESIGN — To $18,000

Engineers capable of analyzing computer systems, skilled in mathematics and familiar with advanced State-of-the-Art digital components such as memories, delay lines, shift registers, etc.; of performing trade-off analysis among the various systems components and methods; of determining the required storage and computation characteristics; of specifying the characteristics, number and interconnection of each of the computer building blocks such as the flip-flops, memory elements, arithmetic registers, analog-to-digital and digital-to-analog devices, etc.

TECHNICAL ASSISTANT — To $18,000

BS/EE and several years of responsible engineering experience in the field of solid state data systems. Background should include specific experience in the engineering development of advanced analog and digital equipment. Responsible for providing technical support to a large systems engineering activity which will include specific trouble-shooting assignments. A desire to assume administrative as well as technical responsibilities will be helpful.

SENIOR PROGRAMMER — $17,500

Math/Physics/EE Deg. (Prefer advanced degree.) Min. 10 yrs professional experience in programming general-purpose computers for scientific and military real time use. Also must be exp. in (a) math problem analyses, flow charting and coding; (b) Planning and development of software (program) packages for binary machines. Applicant will be a lead engineer in a computer systems group, and responsible for detailed knowledge of company's computer line, both commercial and military.

SECTION HEAD MAGNETIC MEMORY SECTION — To $16,000

Leadership and supervision. Design of high speed magnetic memory circuitry and design of transistors magnetic core circuitry.

MATHEMATICIANS — $15,000 UP

For operations research and computer applications. Programming on large scientific types of digital computers and systems designs. Need creative people who have designed compilers; translators, executives, etc.

PRODUCT PLANNERS — $15,000

Math/Statistics Deg. Min. 1 yr exp. programming for magnetic tape computers and/or experience in research type math or stat. Strong interest in non-sales type work centering around development of advanced, scientific and automatic programming techniques.

PROGRAMMERS-SYSTEMS ANALYST — $14,000

Math deg. preferred. Must have min 3 yrs exp. with large-scale computers as IBM 7070 - 7090; Philco 2000; Honeywell 800, etc.

SYSTEMS PROGRAMMERS — $9 - $14,000

Application Programming; design and development of new systems.

SENIOR PROGRAMMER — $14,000 UP

Min. 3 yrs exp in data processing applications on medium scale binary computers. Highly creative approaches to program development for many types of new information systems. Programming decisions requiring optimum utilization of computers for command decisions.

SENIOR PRODUCT PLANNERS — $13,000

Math Deg. Min 2 yrs exp. planning systems on large-scale computers.

SENIOR PROGRAM PLANNERS — $12,000

Math Deg. preferred. Must have compiling or assembly exp on tape computers.

MATHEMATICAL STATISTICIAN — $12,000 UP

MS in Statistics plus four yrs exp. in reliability group designing experiments; analyzing data etc.

TECHNICAL PROPOSAL WRITERS — $10,000 UP

Work with engineering and management in the preparation of technical proposals. Write and/or edit text that clearly and concisely explains techniques and systems concepts. Must be capable of writing engineering reports and handbooks. Prefer applicants with engineering degrees and previous experience in technical writing. Familiarity with methods of reproduction is desirable.

E.D.P. PROGRAMMER — $9,000 UP

Degree in Math/Physics/Statistics. Min 1 yr exp. on medium to large scale electronics digital computers. Responsible for developing the program required for computer solution or processing.

COMMERCIAL TRUST BLDG. • LOCUST 3-4830 • PHILADELPHIA 2, PENNSYLVANIA

NEW LITERATURE . . .

is an illustrated brochure on the 3100 Shoptrol system. Features, functions, and descriptions are given. GENERAL ELECTRIC CO., COMPUTER DEPARTMENT, 13430 No. Black Canyon Highway, Phoenix, Arizona. For copies:

CIRCLE 265 ON READER CARD

CR-201 CARD READER: This bulletin highlights the CR-201, designed to transport cards from a card hopper, past two read stations and into a card stacker at a speed of 30 cards per minute. Included in the bulletin are power requirements, modes of operation, weight, size and features. DATEX CORP. 1307 S. Myrtle Ave., Monrovia, Calif. For copy:

CIRCLE 266 ON READER CARD

ASYNCHRONOUS COMPUTERS: A report on the asynchronous operation of 2000 electronic data processing systems gives background information, description of operation, differences between asynchronous and synchronous systems, and instruction information. PHILCO CORPORATION, COMPUTER DIVISION, 4600 Welsh Road, Willow Grove, Penna. For copy:

CIRCLE 267 ON READER CARD

DC-11 DATA COMMUNICATOR: A bulletin, BSP-05611, describes the DC-11 data communicator, an accessory to the G-20 computer. Speeds for file maintenance, matrix manipulations, and sorting speeds are included. BENDIX COMPUTER DIVISION, 5630 Arbor Vitae St., Los Angeles 45, Calif. For copy:

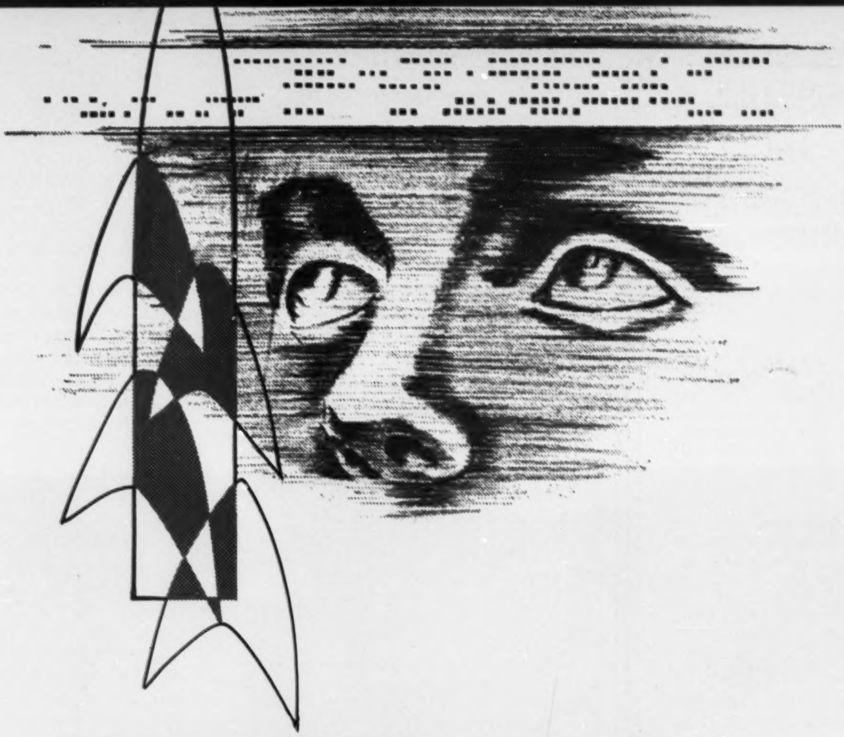
CIRCLE 268 ON READER CARD

PHD-1200 HIGH DENSITY SYSTEM: A data sheet describes the characteristics and operating techniques of the PHD-1200 high density system. An explanation is given of the new contiguous double transition high density system, incorporating the 906II tape handler used in the Bendix G-20 system. POTTER INSTRUMENT CO., Sunnyside Blvd., Plainview, New York. For copy:

CIRCLE 269 ON READER CARD

ANALOG-TO-DIGITAL CONVERTER: A new brochure describes the ADC-1B, a high speed analog to digital converter and gives applications which include industrial process computing systems, computer input systems and portable data acquisition systems. SYSTEMS ENGINEERING LABORATORIES, INC., 4066 N. E. 5th Ave., Ft. Lauderdale, Fla. For copy:

CIRCLE 270 ON READER CARD



people in DATAMATION

■ S. Dean Wanlass has resigned from Aeronutronic to accept the new position of Group Vice President for Packard Bell Computer in charge of the Defense and Industrial Group, Technical Products Division, Computer Division, and Physical Science Corp. Wanlass was one of the founding employees of Aeronutronic since 1956. His most recent title was General Operations Manager, Space Systems Operations.

■ Max Palevsky, vice president and general manager of Packard Bell Computer, resigned from the firm last month. Ken Jackson, Palevsky's administrative assistant, has been appointed acting general manager.

As principal founder of the computer division, Palevsky has been associated with Packard Bell for four years and was formerly with Bendix Computer for five years. Palevsky told DATAMATION that he plans to remain in the computer field but has not as yet announced his future plans.

■ Donald B. Prell has resigned from and sold his interest in Electro Radiation, Inc., a Los Angeles research firm in molecular electronics. With an extensive background in dp and small business management, Prell plans to provide a consulting service with emphasis in applied mergers and capital acquisition for small businesses and independent groups of technical personnel desiring to form their own companies.

■ James P. Boyle has been named manager of data processing services for the Univac Division of Sperry Rand. Prior to joining Univac, Boyle was corporate director of market planning and services with Royal-McBee, as well as serving in various sales management capacities with IBM.

■ Robert M. Gordon, formerly associate director of the Stanford University Computation Center, has been named Manager, Training and Education, for the Commercial Systems Department of RCA's EDP Division. Prior to his association with Stanford, he was with the National Cash Register Co. and Burroughs. Appointed as Manager, Management Science, also in RCA's EDP Division, is Manual E. Haskins, Jr.

■ Control Data Corp. has announced the appointment of Dr. Richard A. Zemlin as Manager of Applications Development for the company's computer division. In his new position, Dr. Zemlin will be responsible for development of CDC's programming systems, including compilers and other programming packages. In another CDC appointment, R. C. Gunderson was named Manager of Computation Services and will take over technical direction for all CDC Service Centers, including contract programming and programming support.

OPPORTUNITIES AT THE OUTER EDGE OF COMPUTER SCIENCE...

Currently members of our computer staff are extending the sensor, problem solving and motor capabilities of computers in novel and exciting directions.

If you would like to join in this stimulating effort on advanced computer applications, investigate the professionally satisfying positions still open on our staff:

RESEARCH MATHEMATICIANS—mastery of numerical techniques, advanced degree. To do original investigations in numerical analysis involving interpolation techniques, differential equations, error analysis, functional approximation, iterative problems, and differential geometry.

SENIOR PROGRAMMERS—experienced with large program organization. To work on multi-programming systems, formal man-machine languages, pattern and character recognition, and numerical control.

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Or, if you prefer, send your résumé immediately to:

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